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# Marburg Virus Disease: Epidemiological Surveillance, Public Health Preparedness, and Infection Control Strategies within Healthcare Systems

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## Abstract

**Background:** Marburg virus disease (MVD) is a severe and often fatal viral hemorrhagic fever caused by Marburg virus (MARV), a high-consequence pathogen within the Filoviridae family. With historical case-fatality rates reaching up to 90%, MVD poses a persistent threat to global public health, particularly in parts of sub-Saharan Africa where sporadic outbreaks occur. The virus circulates in Egyptian fruit bats (*Rousettus aegyptiacus*), with human spillover occurring through exposure to infected bats or their excreta, followed by rapid human-to-human transmission via direct contact with infectious bodily fluids.

**Aim:** This review aims to consolidate current knowledge on the epidemiology, pathogenesis, clinical management, and public health strategies for MVD, with a focus on the critical role of surveillance, healthcare system preparedness, and infection control in mitigating outbreaks.

**Methods:** A comprehensive review of the scientific literature was conducted, synthesizing data on MARV's virology, transmission dynamics, clinical progression, diagnostic approaches, and outbreak response frameworks. Key guidelines from major health organizations, including the World Health Organization (WHO), were incorporated.

**Results:** MVD presents with nonspecific early symptoms (fever, myalgia) before progressing to severe gastrointestinal illness, coagulopathy, hemorrhage, and multi-organ failure. Diagnosis relies on RT-PCR and antigen-capture ELISA. No licensed vaccines or antivirals exist; management is strictly supportive (fluid resuscitation, electrolyte correction) within high-level isolation and infection control protocols. Effective outbreak control depends on rapid case detection, contact tracing, safe burials, and stringent use of personal protective equipment (PPE) in healthcare settings.

**Conclusion:** The high lethality and transmissibility of MARV necessitate robust, coordinated public health responses. Strengthening surveillance, laboratory capacity, healthcare worker training, and community engagement in at-risk regions is paramount to prevent localized outbreaks from escalating into international health emergencies.

**Keywords:** Marburg virus disease, Viral hemorrhagic fever, Filovirus, Outbreak control, Infection prevention, Public health preparedness, Epidemiology, Healthcare systems.

## Introduction

Marburgvirus (MARV), a highly pathogenic, single-stranded RNA virus belonging to the *Filoviridae* family, is the etiologic agent of Marburg virus disease (MVD), a rare but severe viral hemorrhagic fever characterized by high case-fatality rates (CFR) and rapid clinical deterioration.[1][2] MARV shares structural and pathogenic similarities with Ebola virus, and both viruses are among the most lethal infectious agents known to affect humans. According to the World Health Organization (WHO), Marburg virus disease may reach fatality rates as high as 88%, underscoring its capacity for devastating outbreaks and its status as a significant global health


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threat. MVD was first identified in 1967 following simultaneous outbreaks in Germany and Serbia (then part of Yugoslavia), where laboratory workers developed severe hemorrhagic symptoms after contact with tissues from African green monkeys imported from Uganda.[3] For this reason, the disease was historically referred to as "green monkey disease." Subsequent investigations clarified that the virus had been introduced through infected non-human primates, marking the first recognized emergence of MARV as a human pathogen. Since then, sporadic outbreaks and isolated cases have been documented across sub-Saharan Africa, particularly in regions where ecological conditions favor viral maintenance. Reported outbreaks and confirmed cases have occurred in Ghana, Guinea, Kenya, South Africa, Angola, Tanzania, the Democratic Republic of the Congo (DRC), Equatorial Guinea, Uganda, and Rwanda, illustrating the virus's geographical range and endemic potential within certain ecological niches.[4][5][6][7][8][9][10] These events reveal the persistent threat of MARV and highlight the importance of surveillance, rapid response, and global awareness.

The natural reservoir of the virus was later identified through ecological and epidemiological investigations as the Egyptian fruit bat (*Rousettus aegyptiacus*), which harbors the virus asymptomatically.[11] Human infection typically follows exposure to aerosolized particles, saliva, feces, or urine from infected bats, particularly in caves, mines, or other bat-inhabited environments. After zoonotic spillover, human-to-human transmission occurs readily through direct contact with blood and bodily fluids of symptomatic individuals, as well as through contaminated surfaces and materials.[12][13] Healthcare settings pose an especially high risk for secondary transmission due to the high viral load in infected patients and the potential for breaches in infection prevention and control measures. Household transmission is also common, particularly during caregiving or traditional burial practices involving close physical contact. Once inside the host, MARV targets macrophages, dendritic cells, hepatocytes, and endothelial cells, facilitating rapid viral replication and systemic spread.[14] Early symptoms typically resemble other acute febrile illnesses—fever, chills, myalgia, and malaise—which complicates early clinical recognition. As the disease progresses, patients may develop gastrointestinal symptoms, profound lymphopenia, liver failure, coagulopathy, and internal and external hemorrhage. Ultimately, unchecked viral replication and immune dysregulation may culminate in hemorrhagic shock, multiorgan failure, and death, with CFRs reported as high as 90% depending on outbreak resources, virulence, and access to supportive care.[5]

At present, no licensed vaccine or specific antiviral therapy exists for Marburg virus disease, although several experimental treatments and vaccine candidates are under investigation and may offer future promise. Given the rapid disease progression and high mortality, early detection, aggressive supportive care, and strict infection control measures remain the cornerstone of patient management. Supportive interventions—such as fluid resuscitation, electrolyte correction, maintenance of oxygenation, and treatment of secondary infections—can improve survival when implemented promptly. Healthcare workers must maintain a high index of suspicion, especially in regions where MARV is endemic or among patients with relevant travel history, occupational exposure, or contact with wildlife. Swift implementation of infection prevention and control procedures—including isolation, use of personal protective equipment (PPE), contact tracing, and community education—is essential to limit transmission and protect health personnel and vulnerable populations.[15] Given the severe clinical course, absence of curative therapy, and potential for widespread transmission, Marburg virus disease constitutes a major global public health concern. Strengthening national and international preparedness, improving surveillance systems, and ensuring rapid outbreak response capabilities are critical to reducing morbidity and mortality from this highly lethal viral threat [15].

**Etiology**

Marburg virus disease (MVD) is caused by *Marburgvirus* (MARV), a highly pathogenic, enveloped, single-stranded, negative-sense RNA virus belonging to the family *Filoviridae*.[14][16] Members of the *Filoviridae* family are known for causing severe viral hemorrhagic fevers in humans and other mammals. The taxonomy of *Filoviridae* has expanded with advances in genomic sequencing, now encompassing several genera that infect a variety of host species. Among mammals, the medically significant genera include Orthoebolavirus (formerly *Ebolavirus*), Orthomarburgvirus (formerly *Marburgvirus*), Cuevavirus, and Dianlovirus. Additional genera infect other vertebrates: Oblavirus, Loebevirus, Thamnovirus, and Striavirus infect fish, while Tapjovirus infects reptiles.[17][18] These classifications reflect the genetic diversity and ecological breadth of filoviruses, although only a small subset—including MARV—are known to cause severe human disease. Marburg virus disease results from infection by one of two genetically distinct viruses within the Orthomarburgvirus genus: Marburg virus (MARV) and Ravn virus (RAVV). These two viruses exhibit approximately 20% genetic divergence, yet both cause indistinguishable clinical illnesses in humans.[18] MARV and RAVV together comprise the species *Orthomarburgvirus marburgense*, a single recognized species within the

*Orthomarburgvirus* genus. Like Ebola viruses, both MARV and RAVV can infect humans and nonhuman primates, causing fulminant hemorrhagic fever syndromes with case-fatality rates reaching as high as 90% during some outbreaks.[19] Their capacity for rapid replication, systemic dissemination, and profound dysregulation of the host immune response underscores their classification among the most dangerous viral pathogens known.

Within MARV itself, several variants have been identified through molecular epidemiology. Notable among these are the Marburg Mt. Elgon variant (MARV/MtE-Mus)—also known as *Marburg Musoke* or *MARV/Mus*—and the Marburg Angola variant (MARV/Ang).[20] The Angola variant is of particular scientific and public health concern, as it is significantly more virulent than the Musoke variant and has been associated with exceptionally high case-fatality rates. Due to its heightened pathogenicity and consistent lethality in experimental models, MARV/Ang has become the research standard for laboratory studies, including investigations into pathogenesis, antiviral therapies, and vaccine development.[21] The natural reservoir of MARV is believed to be the Egyptian fruit bat (*Rousettus aegyptiacus*), a species widely distributed across Africa. These bats can harbor the virus asymptomatically, facilitating its persistence in the environment and intermittent spillover into humans. Transmission to humans typically occurs through exposure to infected bats in caves or mines, or through contact with their secretions and excreta. Once introduced into human populations, MARV spreads efficiently via direct contact with blood, bodily fluids, tissues, or contaminated surfaces, with both household caregivers and healthcare workers at significant risk during outbreaks. Due to its extreme pathogenicity, ease of transmission through contact with infectious materials, environmental persistence in certain settings, and the absence of approved vaccines or specific antiviral treatments, MARV is classified as a WHO Risk Group 4 pathogen—the highest level of biosafety concern.[14] This classification mandates advanced containment facilities for laboratory handling and reflects the virus's potential for severe outbreaks with high mortality. The combination of high virulence, lack of medical countermeasures, and challenging reservoir dynamics positions MARV as a pathogen of urgent global health importance [14][21].

**Epidemiology**

Marburg virus disease is caused by MARV, an enveloped, single-stranded, negative-sense RNA virus of the family Filoviridae that was first recognized as a human pathogen during an outbreak in Europe in 1967.[3][14][16] Since its discovery, MVD has been characterized as a highly virulent hemorrhagic fever with a wide but well-defined incubation period, typically ranging from 3 to 21 days, and most frequently between 5 and 10 days.[3][14][16] The length of this incubation interval is influenced by both the route of exposure—such as percutaneous, mucosal, or aerosol contact—and the magnitude of the infectious dose. Importantly, available evidence indicates that viral shedding sufficient for transmission generally begins after the onset of clinical symptoms, rather than during the incubation phase, which has notable implications for public health control strategies and the timing of isolation measures. Clarifying the ecology of MARV and defining its natural reservoir have posed significant challenges, largely because outbreaks often occur in remote regions and access to wildlife populations for sampling is limited. Nevertheless, converging epidemiological, ecological, and virological data have identified the Egyptian fruit bat, *Rousettus aegyptiacus*, as the principal reservoir host for Marburg virus disease.[22] These bats can carry MARV without overt clinical illness and excrete the virus, enabling silent maintenance and environmental dissemination. Other bat species, including members of the order Chiroptera and the species *Hipposideros caffer*, have also been implicated as potential hosts, although current evidence suggests that they likely play a lesser role in sustaining viral circulation.[22] Whether *Rousettus aegyptiacus* is the sole reservoir species or part of a broader reservoir community remains an area of ongoing investigation. Infected fruit bats develop subclinical infections and shed MARV through saliva, urine, and possibly feces, thereby creating opportunities for zoonotic spillover when humans enter bat-inhabited caves, mines, or roosting sites.[23] Once MARV has crossed the species barrier, human-to-human transmission occurs primarily via direct contact with infectious body fluids—including blood, saliva, sweat, urine, stool, vomitus, and breast milk—or with fomites contaminated by these secretions.[23]

The bat reservoir was first strongly implicated through outbreak investigations that identified a shared environmental exposure among affected individuals. A seminal example is the large outbreak that occurred in the Democratic Republic of the Congo (DRC) between 1998 and 2000.[16] In this event, the majority of index cases were young male gold miners working in the Goroumbwa mine near Durba, where dense colonies of *Rousettus aegyptiacus* bats resided. Repeated close contact with bats and their excreta within the confined cave environment provided an ideal setting for zoonotic transmission, after which infected miners carried MARV back to their households and communities, sustaining secondary chains of human-to-human spread.[16] Molecular analyses from this outbreak revealed the presence of multiple genetically distinct MARV strains, suggesting repeated independent spillover events rather than a single introduction, thereby illustrating both the complexity of the reservoir–host interface and the potential for

sustained viral circulation within bat populations.[24] Remarkably, human cases continued to occur until mining operations were halted and the mine flooded, further emphasizing the central role of environmental exposure to infected bats in MVD epidemiology.[16][24] Subsequent biosurveillance studies conducted in non-outbreak settings have confirmed that a substantial proportion of *Rousettus aegyptiacus* bats harbor subclinical infection and intermittently shed MARV, corroborating their status as a key reservoir species.[23] Historically, the first recognized outbreak of Marburg virus disease occurred in August 1967, affecting laboratory and healthcare workers in Marburg and Frankfurt, Germany, and in Belgrade, then part of Yugoslavia (now Serbia).[25][26] A total of 37 individuals developed infection following occupational exposure to tissues and blood from African green monkeys (*Cercopithecus aethiops*) imported from Uganda for vaccine production and research.[25][26] Among these cases, 31 manifested severe disease, and 7 died, corresponding to a case-fatality rate (CFR) of approximately 23%.[25][26] Because most cases occurred in the city of Marburg, the virus was named after this locality. This outbreak also yielded early evidence suggesting the possibility of sexual transmission during convalescence, as MARV was detected in the semen of a recovering patient, raising concerns about prolonged viral persistence in immune-privileged sites.[27]

The first reported African case, and the second recognized MVD event globally, occurred in 1975, when an Australian traveler who had hitchhiked through Zimbabwe (then Rhodesia) became ill and was hospitalized in Johannesburg, South Africa.[28] He subsequently died due to disseminated intravascular coagulation, but the two individuals he infected survived, resulting in a CFR of approximately 33% in that cluster.[28] Over the ensuing decades, multiple outbreaks and sporadic cases were documented in the DRC, Kenya, Uganda, Angola, Ghana, and Rwanda, reflecting the endemic presence of MARV in several regions of sub-Saharan Africa.[4][5][6][7][8] Among these, two large and prolonged outbreaks are of particular significance. The first, in the DRC between 1998 and 2000, involved 154 reported cases and 128 deaths, corresponding to a CFR of 83%.[5] The second, in Angola between 2004 and 2005, represented the largest recorded MVD outbreak, with 422 reported cases and 356 deaths, yielding a CFR of 84%.[5][6] These events underscored the potential for MARV to cause extensive community transmission, especially in settings with limited health infrastructure and delayed recognition. More recently, the geographical footprint of reported outbreaks has expanded. In 2022, Ghana documented its first recognized Marburg virus disease outbreak, marking an important extension of known MARV activity within West Africa.[4] In 2023, Tanzania reported its first outbreak, further illustrating the broad ecological range of the virus within the continent. In September 2024, the Ministry of Health of Rwanda announced the country's first recorded MVD outbreak, with 63 cases and 15 deaths reported at the time of documentation, and transmission still ongoing.[7] These recent outbreaks highlight both the persistent threat of MARV and the pressing need for sustained surveillance, diagnostic capacity, and rapid response mechanisms within affected regions. Most Marburg virus disease outbreaks, both historical and recent, have been managed through collaborative efforts involving national governments, Ministries of Health, local public health authorities, and international agencies, including the World Health Organization (WHO), the Africa Centres for Disease Control and Prevention, and the United States Centers for Disease Control and Prevention (CDC).[29] Key control strategies have included rigorous contact tracing to identify and monitor exposed individuals, active case finding and surveillance to detect new infections early, and the implementation of stringent infection prevention and control measures in healthcare facilities and at the community level.[29] These interventions—coupled with risk communication, community engagement, and safe burial practices—have been instrumental in interrupting transmission chains and containing outbreaks. However, the recurring emergence of MVD underscores the ongoing vulnerability of populations living in close proximity to bat reservoirs and highlights the critical importance of strengthening health systems, laboratory infrastructure, and cross-border coordination to mitigate the impact of future Marburg virus disease events.

**Pathophysiology**

Marburg virus disease results from a complex cascade of virological and immunopathological events that begins with the entry of MARV into the host and culminates in profound systemic dysfunction. Infection typically follows direct contact with contaminated bodily fluids—such as blood, vomitus, stool, urine, saliva, or breast milk—or through exposure to infected animals or humans.[30] The virus gains access to the body primarily via breaches in the skin or through intact but vulnerable mucosal surfaces, including those of the oral cavity, conjunctivae, and genital tract.[30] Once MARV crosses these initial barriers, it targets cells of the mononuclear phagocyte system, particularly monocytes, macrophages, and dendritic cells, which serve as the first sites of viral replication and as vehicles for subsequent dissemination throughout the host. After initial infection of these antigen-presenting cells, MARV is transported to and amplifies within secondary lymphoid and reticuloendothelial organs, most notably the liver, lymph nodes, and spleen.[30] These tissues provide a

permissive environment for early viral replication and systemic spread. The extensive infection of antigen-presenting cells and reticuloendothelial structures profoundly disrupts normal immune function. Infected macrophages and dendritic cells release large quantities of proinflammatory mediators, including cytokines and chemokines, which drive a dysregulated inflammatory response often described as a "cytokine storm." This exaggerated immune activation is accompanied by lymphoid depletion in the spleen and other lymphoid tissues, reflecting both direct viral cytopathic effects and apoptosis of lymphocytes.[30][31] Rather than eliminating the virus, this maladaptive immune response contributes significantly to tissue injury and organ dysfunction [30].

Systemic inflammation is central to the pathogenesis of Marburg virus disease. Proinflammatory mediators, including prostacyclin and nitric oxide, are produced in excess and exert profound effects on the vascular endothelium, coagulation pathways, and hemodynamic stability.[31] These mediators increase vascular permeability, promote vasodilation, and disturb the delicate balance between procoagulant and anticoagulant mechanisms. The activation of the coagulation cascade is a hallmark of severe MVD and leads to disseminated intravascular coagulation (DIC), in which widespread microthrombi form within the vasculature.[31] As clotting factors and platelets are consumed, patients paradoxically develop a bleeding diathesis, characterized by mucosal hemorrhage, petechiae, ecchymoses, and uncontrolled internal bleeding. This combination of microvascular thrombosis and hemorrhage contributes to multiorgan ischemia, shock, and, in many cases, death. At the molecular level, MARV entry into host cells is mediated by its envelope glycoprotein (GP), which is the principal viral attachment factor and a critical determinant of tissue tropism and pathogenicity.[32] The MARV glycoprotein exists as a class I fusion glycoprotein and comprises two functional subunits. The surface subunit, GP1, is responsible for binding to host cell receptors, whereas the transmembrane subunit, GP2, contains an internal fusion loop that inserts into the host cell membrane to facilitate fusion of viral and cellular membranes.[32] Through this coordinated mechanism, MARV gains access to the cytoplasm of susceptible cells. In many respects, the entry pathway utilized by MARV resembles that of Ebola virus (EBOV), another filovirus, highlighting conserved strategies among these highly pathogenic viruses for breaching host cellular defenses.[32][33]

Beyond its role in attachment and fusion, MARV glycoprotein contributes to immune evasion. Glycoprotein expression has been implicated in the functional inactivation of neutrophils and in interference with normal immune signaling pathways, thereby impairing effective innate immune responses.[33] By blunting neutrophil function and altering cytokine profiles, MARV fosters an environment in which viral replication can proceed unchecked while the host's ability to mount a coordinated antiviral defense is compromised. Following initial attachment of GP1 to host cell receptors, MARV is internalized via endocytosis into the endosomal compartment.[34] Within endosomes, GP1 undergoes proteolytic cleavage by host endosomal proteases, a step that is essential for exposing receptor-binding domains required for subsequent interactions.[34] A key event in this process is the engagement of the viral glycoprotein with Niemann-Pick C1 (NPC1), an endosomal cholesterol transporter that serves as an essential intracellular receptor for filovirus entry.[34] Binding to NPC1 triggers conformational changes in GP2, promoting fusion of the viral envelope with the endosomal membrane and release of the viral nucleocapsid into the host cell cytoplasm. Once the viral core enters the cytoplasm, MARV commandeers the host's cellular machinery to initiate transcription of its negative-sense RNA genome and translation of viral proteins.[34] The virus assembles new nucleocapsids and buds from the plasma membrane, acquiring its lipid envelope and glycoprotein spikes in the process. This productive infection cycle, occurring in multiple organs but particularly prominent in the liver, spleen, and endothelial cells, leads to escalating viremia. The combination of direct cytopathic effects, pronounced immune dysregulation, coagulopathy, and endothelial damage culminates in the fulminant clinical picture of Marburg virus disease, characterized by high fever, gastrointestinal symptoms, hemorrhage, shock, and multiorgan failure.[30][31][34]

**History and Physical**

A meticulous medical history and comprehensive physical examination are fundamental to the evaluation of any patient with suspected Marburg virus disease and form the cornerstone of early recognition and appropriate management. The history must be explicitly oriented toward identifying epidemiologic risk factors and potential exposures that raise the pretest probability of infection. Particular emphasis should be placed on recent travel to or residence in regions where Marburg virus disease has been reported, especially areas of sub-Saharan Africa with known circulation of MARV.[14][35] Clinicians should inquire about visits to caves or mines, especially those inhabited by large colonies of fruit bats, as well as any direct or indirect encounters with bats, including visual observation, handling, or exposure to bat excreta. A history of work in or around facilities that handle nonhuman primates (NHPs) or conduct research on viral hemorrhagic fevers is also highly relevant, as occupational exposure in such settings has been documented in earlier outbreaks.[3][14][16] Patients at greatest risk of infection are those with close

contact with key sources of MARV. These include individuals who have had exposure to excreta of fruit bats, particularly travelers or workers who have recently visited endemic areas in Africa or entered caves and mines known to harbor *Rousettus aegyptiacus* populations.[14] Household members or caregivers who have provided direct care to persons acutely ill with Marburg virus disease, including family members and hospital staff, constitute another major risk group, given the well-established potential for human-to-human transmission through contact with blood and bodily fluids. Individuals handling or being in close proximity to NHPs infected with MARV, such as researchers, animal caretakers, and workers in primate facilities, are similarly vulnerable. In addition, laboratory personnel working in facilities that study viral hemorrhagic fevers may be at risk through accidental occupational exposure. A thorough occupational and social history must therefore probe for such contacts, including participation in funeral rituals involving direct handling of the deceased, which has been a key driver in several filoviral outbreaks.[14][16][35]

Following exposure and successful infection, patients enter an incubation period that typically ranges from 3 to 21 days, with most cases presenting between 5 and 10 days after exposure.[35] During this phase, individuals remain asymptomatic and non-infectious, which complicates detection and surveillance. The subsequent clinical presentation is influenced by several factors, including the virulence of the infecting strain—such as the highly pathogenic MARV/Angola variant—and the host's immunological status and underlying comorbidities.[16][35] Once the incubation period ends, patients generally develop an abrupt onset of illness characterized by nonspecific, systemic symptoms that closely resemble many other tropical and infectious diseases, making early recognition challenging in the absence of epidemiologic clues.

The illness course of Marburg virus disease is often conceptualized in three overlapping phases: the initial generalized phase, typically occurring from days 1 to 4 of symptomatic illness; the early organ phase, extending roughly from days 5 to 13; and the late organ or convalescent phase, beginning after day 13.[16][35] During the generalized phase, patients frequently present with sudden high fever, intense chills, diffuse myalgias and arthralgias, severe headache, and marked malaise. These influenza-like symptoms may be accompanied by anorexia and profound fatigue, and at this stage the clinical picture can be indistinguishable from malaria, typhoid fever, dengue, or other systemic infections common in endemic regions. Gastrointestinal manifestations may develop early or shortly thereafter, and many patients rapidly progress to significant nausea, repeated vomiting, abdominal pain, and profuse watery diarrhea within the first 2 to 5 days of illness. This combination of high fever and gastrointestinal fluid losses contributes to early volume depletion and hemodynamic instability if fluid replacement is inadequate.[16][35] As the disease advances into the early organ phase, generally between days 5 and 7, additional characteristic features begin to emerge. A maculopapular, erythematous, nonpruritic rash often appears, commonly involving the trunk and proximal extremities.[16] Petechiae may also be visible, reflecting early involvement of the microvasculature and beginning coagulopathy. Conjunctival injection is frequently observed and may be accompanied by photophobia. Patients can experience dramatic temperature lability, with alternating episodes of hyperpyrexia and relative hypothermia, indicating systemic dysregulation. It is during this phase that classical manifestations of viral hemorrhagic fever typically become apparent. Findings may include mucosal bleeding such as epistaxis and gingival hemorrhage, hematemesis, hematochezia, melena, and oozing from venipuncture or injection sites. Bruising, ecchymoses, and worsening petechial hemorrhages further underscore the underlying coagulopathy.[16][35] Disseminated intravascular coagulation generally develops within the first week of symptomatic illness and contributes to both microvascular thrombosis and increased bleeding risk.[14][35]

Severe cases progress to hypotension, refractory shock, and multiorgan failure as the disease continues through the early organ phase. Hepatic involvement may manifest as jaundice, coagulopathy, and rising transaminase levels; renal dysfunction may present with oliguria or anuria and rising creatinine; and respiratory compromise may result from pulmonary edema or secondary infections. Neurological involvement, which often appears in the later part of the early organ phase or early in the late organ phase, can include agitation, delirium, confusion, seizures, and ultimately coma in critically ill patients.[14][16][35] These neurological signs often portend a poor prognosis, especially when accompanied by sustained hypotension and evidence of progressive organ failure. The late organ or convalescent phase, which begins after approximately day 13 of illness, is characterized by a dichotomous clinical trajectory.[16][35] Some patients succumb to the combined effects of severe hemorrhage, shock, and multiorgan failure, typically in the second week of illness. Those who survive this critical period may enter a prolonged recovery phase, during which the acute hemorrhagic manifestations gradually resolve, but significant weakness, weight loss, and functional impairment persist. Convalescent individuals may report arthralgias, myalgias, fatigue, and neuropsychiatric symptoms such as irritability, insomnia, or difficulty concentrating. In addition, MARV, like Ebola virus, may persist in immune-privileged sites such as the testes, ocular tissues, or

central nervous system, raising concerns about post-recovery sequelae and potential delayed transmission events, particularly via sexual contact.[27][35]

On physical examination, findings are dynamic and evolve with disease progression. Early in the course, vital signs often reveal high fever and tachycardia, while the general appearance is typically one of marked illness and prostration. As the disease advances, signs of volume depletion and shock—tachycardia, hypotension, delayed capillary refill, cool extremities, and altered mental status—may emerge. Dermatologic examination may show the characteristic maculopapular rash and petechiae. Conjunctival injection, pharyngeal erythema, and mucosal bleeding are common. Abdominal examination may reveal diffuse tenderness, particularly in the epigastric or periumbilical regions, and in later stages, hepatomegaly may be present. A focused neurologic assessment is essential to detect early changes in sensorium or focal deficits. Overall, the integration of a detailed exposure history with these evolving clinical and physical findings is critical for raising suspicion of Marburg virus disease, initiating appropriate isolation, and pursuing confirmatory diagnostic testing in a timely manner.[14][16][35]

**Evaluation**

The evaluation of patients with suspected Marburg virus disease requires a multifaceted approach that integrates clinical assessment, laboratory testing, epidemiologic investigation, and coordination with public health authorities. Given the severity of the disease and its potential for rapid deterioration, early recognition of characteristic laboratory abnormalities and timely implementation of confirmatory testing are essential for guiding patient management and preventing further transmission. Laboratory findings play a critical role in the early identification of Marburg virus disease, particularly because the initial clinical manifestations are nonspecific and overlap with many endemic infectious diseases. Among the earliest and most consistent abnormalities are elevations in liver enzymes, particularly alanine aminotransferase (ALT) and aspartate aminotransferase (AST), reflecting hepatocellular injury caused by direct viral infection of hepatocytes and extensive immune-mediated damage.[14] Rising serum creatinine levels are also common and may indicate early renal impairment due to volume depletion, shock, or direct viral involvement of renal tissues. In addition, hematologic abnormalities form a hallmark of MARV infection. Profound lymphopenia and thrombocytopenia often develop during the first week of illness, reflecting extensive viral replication within immune cells and bone marrow suppression. Coagulation studies frequently reveal prolonged prothrombin time and other markers consistent with evolving disseminated intravascular coagulation (DIC), which correlates with the onset of hemorrhagic manifestations and increased mortality risk.[14] These laboratory findings, although not specific to MARV, contribute significantly to raising clinical suspicion in the appropriate epidemiologic context. Definitive diagnosis relies on virologic and serologic testing. Diagnostic confirmation can be achieved using antigen-capture enzyme-linked immunosorbent assay (ELISA), reverse transcription–polymerase chain reaction (RT-PCR), or IgM-capture ELISA, all of which are capable of detecting infection within a few days after symptom onset.[16] Among these modalities, PCR is considered the preferred diagnostic tool because of its superior sensitivity during the early stages of disease, its ability to detect low levels of viral RNA, and its capacity to differentiate between various Marburg virus strains.[16] These advantages are especially pertinent in the context of outbreak investigation and epidemiological surveillance. IgM-capture ELISA becomes useful slightly later in the symptomatic period but remains an important adjunct for confirming acute infection once humoral immune responses begin to develop. IgG-capture ELISA, by contrast, is most valuable for retrospective diagnosis, surveillance studies, and identification of individuals with past infection, as IgG antibodies take longer to appear and persist after recovery [14][16].

Virus isolation, although considered the gold standard for confirming filovirus infection, is rarely performed in routine clinical practice due to the extreme biosafety risks associated with handling live MARV. Isolation procedures must be conducted exclusively in high-containment laboratories, specifically Biosafety Level 4 (BSL-4) facilities, which employ specialized engineering controls, personal protective equipment, and stringent protocols to prevent laboratory-acquired infection.[16] Consequently, virus isolation is typically reserved for research purposes, advanced characterization of viral strains, or specialized public health investigations rather than frontline diagnostic evaluation. Specimen collection for laboratory testing must be performed with meticulous attention to biosafety precautions. Blood is the most commonly used diagnostic specimen, but other bodily fluids—such as urine, saliva, or swabs from mucosal surfaces—may be appropriate depending on the stage of illness and available testing platforms. In fatal cases, tissue samples collected during autopsy may be used to confirm infection, although such procedures must be performed under strictly controlled conditions due to the high infectivity of MARV in deceased individuals.[36] Because of the public health implications of Marburg virus disease, clinicians must promptly notify their state or national health department as soon as a suspected or confirmed case is identified. Public health authorities provide essential guidance on appropriate specimen handling, laboratory submission, isolation procedures, and contact tracing. They also coordinate

with specialized reference laboratories capable of performing confirmatory testing. Early communication is critical not only for facilitating accurate diagnosis but also for mobilizing rapid public health interventions aimed at preventing further transmission in the community and healthcare settings.[36] In summary, the evaluation of Marburg virus disease requires a coordinated diagnostic strategy that combines recognition of characteristic laboratory abnormalities, rapid application of molecular diagnostic tools, strict adherence to biosafety procedures, and immediate engagement with public health infrastructure. Early and accurate diagnosis is essential to guide clinical management, initiate supportive care, protect healthcare workers, and limit the spread of this highly dangerous pathogen [14][16][35][36].

**Treatment / Management**

The management of Marburg virus disease is centered primarily on meticulous supportive care and rigorous implementation of infection prevention and control measures, as no specific antiviral therapy has yet received regulatory approval.[16] Supportive care aims to stabilize physiological functions, mitigate complications, and provide the host with the best possible conditions to mount an effective immune response. This typically includes aggressive fluid resuscitation with intravenous crystalloids to correct hypovolemia, careful electrolyte replacement to address disturbances arising from vomiting and diarrhea, supplemental oxygen to optimize tissue oxygenation, and, when indicated, transfusion of blood or blood products to treat anemia or coagulopathy.[16] Intensive monitoring of hemodynamic status, urine output, mental state, and organ function is essential, with early escalation to critical care support in patients exhibiting signs of shock or multiorgan failure. In parallel, the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) have issued detailed guidelines for infection prevention and control in healthcare settings to reduce the risk of nosocomial transmission.[15] Core infection control precautions are indispensable when caring for patients with confirmed or suspected Marburg virus disease. Patients should be placed in single rooms with closed doors to reduce contact with other patients and limit environmental contamination.[15] Healthcare workers must consistently utilize appropriate personal protective equipment (PPE), including gloves, gowns, eye protection, and respirators when indicated, particularly during procedures with potential for exposure to blood and bodily fluids. The preference for disposable patient care equipment, where feasible, minimizes the risk associated with decontamination and reuse. Invasive procedures such as venipuncture and intramuscular injections should be restricted to those that are strictly necessary, due to the dual risks of sharps injury to staff and bleeding in thrombocytopenic patients. Aerosol-generating procedures, including intubation, suctioning, and noninvasive ventilation, should be avoided when possible or conducted with heightened precautions in appropriately equipped settings. Frequent and thorough hand hygiene, using either alcohol-based hand rubs or soap and water, is a critical component of infection control practice. Moreover, healthcare systems must have mechanisms for monitoring, counseling, and managing potentially exposed personnel, ensuring timely post-exposure assessment and work restrictions when warranted. Visitor access to the rooms of infected patients should be prohibited or, in exceptional circumstances, strictly controlled.[15]

In addition to supportive care and infection control, a growing body of research is focused on the development of pharmaceutical antiviral agents for Marburg virus disease. Although none are currently licensed for clinical use, several candidates have shown promise in preclinical and early-phase clinical studies. Galidesivir (BCX4430), a synthetic nucleoside analog, is one of the most extensively studied. This molecule exerts its antiviral effect by inhibiting viral RNA-dependent RNA polymerase, a key enzyme required for viral genome replication.[37] In rodent models, post-exposure intramuscular administration of BCX4430 provided significant protection against MARV infection when treatment was initiated within 48 hours after exposure, whether the virus had been delivered intraperitoneally or via aerosol.[37] The efficacy of BCX4430 has also been evaluated in nonhuman primates. In a pivotal study, cynomolgus macaques infected with lethal doses of wild-type MARV were treated with intramuscular BCX4430 twice daily for 14 days. While untreated control animals succumbed to infection, all macaques that received BCX4430 beginning 24 to 48 hours after infection survived, demonstrating robust protective effects.[38] A phase 1, double-blind, placebo-controlled, dose-ranging clinical trial in 32 healthy human subjects (NCT03800173) has been conducted to evaluate the single-dose safety, tolerability, and pharmacokinetics of BCX4430, marking an important step toward potential therapeutic application.[37][39] Other antiviral candidates under investigation include favipiravir, a synthetic guanidine nucleoside, and remdesivir, a prodrug of an adenosine analog.[40] Remdesivir has demonstrated broad-spectrum activity against multiple RNA viruses, and preclinical studies have shown that it possesses inhibitory effects against MARV in animal models.[40] Notably, combination therapy with remdesivir and the monoclonal antibody MR186 yielded encouraging results in nonhuman primates, with treatment initiated even at advanced stages of disease capable of reversing clinical signs and improving survival outcomes.[41] Interferon-beta has also been explored as an immunomodulatory

therapy; in experimental monkey models, interferon-beta administration was associated with prolonged survival, suggesting a potential adjunctive benefit, although its precise clinical role remains to be defined.[42]

Beyond small-molecule antivirals, immunotherapeutic strategies, particularly monoclonal antibodies, have emerged as a promising avenue for targeted treatment. Monoclonal antibodies derived from B cells of patients who survived Marburg virus disease, such as MR186 and MR191, have shown substantial protective efficacy in nonhuman primate models.[43] In studies involving rhesus macaques experimentally infected with MARV, administration of these monoclonal antibodies resulted in survival rates ranging from 80% to 100%, even when therapy was initiated after the onset of clinical symptoms.[43] These findings parallel advances seen in Ebola virus disease, where monoclonal antibody therapies have transitioned from experimental agents to licensed treatments, and they suggest a viable pathway for similar progress in Marburg virus disease management. In parallel with therapeutic development, significant global efforts are directed toward the creation of effective vaccines against filoviruses, including MARV.[44] A broad array of vaccine platforms is being explored, reflecting the complexity of eliciting durable and protective immunity. These platforms include inactivated whole-virus vaccines, replication-competent viral vectors, virus-like replicon particles, adenovirus-vectored vaccines, DNA-based vaccines, virus-like particles, replication-incompetent viral vectors, recombinant vesicular stomatitis virus constructs, and mixed-modality approaches that combine different technologies.[44] The West African Ebola epidemic of 2013–2016 provided both impetus and infrastructure for accelerating vaccine research and development, leading to the rapid advancement and eventual licensure of effective Ebola vaccines. Despite these achievements, challenges specific to MARV remain. These include the relative rarity and unpredictability of Marburg outbreaks, which complicate the design and implementation of large-scale efficacy trials, as well as the need for more robust immunogenicity and safety data in humans. Consequently, while several Marburg vaccine candidates have demonstrated promising immunogenicity and protection in animal models, further research is required to clarify their utility, optimize dosing regimens, and determine their role in outbreak response and pre-exposure prophylaxis for high-risk populations.[44] In summary, current treatment of Marburg virus disease is dominated by high-quality supportive care and stringent infection control, both of which are vital for improving individual outcomes and preventing secondary transmission. At the same time, a rapidly evolving pipeline of antiviral agents, monoclonal antibodies, and vaccine candidates offers cautious optimism that more specific and effective interventions will become available in the future. Until such tools are fully validated and widely accessible, early recognition, prompt supportive management, and rigorous adherence to established infection prevention protocols remain the pillars of effective Marburg virus disease control [44].

**Differential Diagnosis**

Accurate diagnosis of Marburg virus disease in its early stages presents a substantial clinical challenge because the initial manifestations—fever, headache, myalgia, malaise, and gastrointestinal symptoms—are nonspecific and overlap extensively with a wide range of infectious diseases endemic to the same geographic regions. In the absence of distinct early clinical markers, clinicians must rely heavily on epidemiologic context, exposure history, and a systematic approach to differential diagnosis to guide timely evaluation and isolation measures. Failure to recognize Marburg virus disease promptly can delay appropriate infection control interventions, posing significant risks for rapid transmission, particularly in healthcare and household settings. One of the closest clinical mimickers is Ebola virus disease, another filoviral hemorrhagic fever with similar modes of transmission, incubation periods, clinical evolution, and high case-fatality rates. Both conditions can present with abrupt onset of fever, severe gastrointestinal symptoms, maculopapular rash, coagulopathy, and hemorrhage, making laboratory testing essential for distinguishing between them. Lassa fever, an arenavirus endemic in West Africa, also manifests with fever, malaise, pharyngitis, retrosternal pain, and in severe cases, hemorrhage and multiorgan dysfunction. The presence of gradual rather than abrupt symptom progression and characteristic auditory findings in Lassa fever may offer subtle clinical distinctions, but definitive diagnosis requires specialized laboratory assays [36][37][39][44].

Other viral infections commonly encountered in tropical regions must also be considered. Dengue fever can closely resemble Marburg virus disease in its early febrile phase and may progress to dengue hemorrhagic fever, which presents with plasma leakage, thrombocytopenia, and bleeding tendencies. Malaria, particularly severe *Plasmodium falciparum* malaria, is a frequent cause of high fever, anemia, shock, and altered mental status in endemic areas. Thick and thin blood smears are vital to differentiate malaria from viral hemorrhagic fevers in the acute phase. Bacterial infections comprise another important category of differential diagnoses. Typhoid fever may present with prolonged fever, abdominal pain, rose spots, hepatosplenomegaly, and gastrointestinal symptoms—findings that may overlap with early Marburg virus disease. Rickettsial illnesses, such as typhus or spotted fever, can also manifest with fever, rash, myalgia, and neurological features.

Additionally, Shigellosis presents with febrile diarrhea, abdominal cramps, and dysentery, which may resemble the gastrointestinal phase of MARV infection; however, Shigella infections are typically distinguished by their rapid response to targeted antimicrobial therapy and the absence of coagulopathy. Central nervous system infections such as meningitis—whether bacterial, viral, or fungal—must be evaluated, particularly when patients present with headache, neck stiffness, photophobia, or altered mental status. While hemorrhagic manifestations are not a characteristic feature of meningitis, severe cases may lead to septic shock, disseminated intravascular coagulation, and multiorgan failure, further complicating the clinical picture. Ultimately, distinguishing Marburg virus disease from these various differential diagnoses requires a combination of clinical vigilance, detailed travel and exposure history, and laboratory confirmation. Given the potential for rapid clinical deterioration and high transmissibility, clinicians must consider Marburg virus disease in any patient with compatible symptoms and epidemiologic risk factors, implementing appropriate infection control measures while awaiting definitive diagnostic results [44].

**Treatment Planning**

The treatment planning for Marburg virus disease must be systematic, multidisciplinary, and highly structured, given the infection's fulminant clinical course, high case-fatality rate, and potential for nosocomial and community transmission. Management strategies encompass hospital-based isolation and supportive care, advanced hemodynamic and organ support, meticulous symptom control, judicious consideration of experimental therapies, continuous monitoring, and robust infection control and public health measures. Although no specific antiviral therapy has yet received regulatory approval for Marburg virus disease, optimized supportive management and strict adherence to infection prevention guidelines remain the central pillars of care and can significantly improve patient outcomes. From the moment Marburg virus disease is suspected, the priority is immediate and appropriate hospitalization under conditions that minimize the risk of spread. Ideally, patients should be managed in specialized isolation units, with preference for facilities that meet Biosafety Level 4 (BSL-4) standards when available, particularly for procedures involving high-risk laboratory handling or aerosol-generating interventions. In most settings, this translates into placement in a single, closed room with restricted access, negative-pressure ventilation if possible, and clearly delineated zones for donning and doffing personal protective equipment (PPE). Infection prevention practices must incorporate contact and droplet precautions at a minimum, with airborne precautions considered for procedures that may generate aerosols. Healthcare workers caring for these patients should use full PPE, including gloves, impermeable gowns, eye and face protection, and, when appropriate, fit-tested respirators. These measures are essential to protect healthcare personnel, other patients within the facility, and the broader community, as healthcare-associated transmission has been a major driver of prior filovirus outbreaks. Clear institutional protocols, staff training, and regular drills greatly enhance adherence and reduce the risk of protocol breaches [44].

Within this controlled environment, supportive care focused on hemodynamic stabilization and organ support constitutes the core of treatment. Marburg virus disease frequently leads to substantial fluid losses secondary to high fever, vomiting, and profuse diarrhea, and these, combined with systemic vasodilation, can rapidly culminate in hypovolemia and shock. Intravenous crystalloid fluids should be administered to restore and maintain adequate intravascular volume, with careful titration based on clinical examination, urine output, and dynamic hemodynamic parameters. Over-resuscitation must be avoided, particularly in patients developing pulmonary involvement, to reduce the risk of pulmonary edema. Electrolyte derangements, including abnormalities in sodium, potassium, calcium, and magnesium, are common owing to gastrointestinal losses and evolving organ dysfunction; these must be closely monitored with serial laboratory tests and corrected promptly to prevent arrhythmias, neuromuscular complications, and worsening hemodynamic instability. In cases where blood pressure remains low despite adequate volume resuscitation, vasopressor support with agents such as norepinephrine may be necessary to maintain adequate mean arterial pressure and organ perfusion. Organ support strategies must be tailored to the evolving clinical picture. Acute kidney injury is a frequent complication in severe Marburg virus disease, driven by hypotension, direct viral effects, and disseminated intravascular coagulation. When renal failure progresses to oliguria or anuria with metabolic derangements, renal replacement therapy in the form of intermittent hemodialysis or continuous renal replacement therapy becomes essential. Similarly, the respiratory system may be compromised by severe sepsis, shock, pulmonary edema, or secondary infections, necessitating supplemental oxygen and, in more severe cases, noninvasive or invasive mechanical ventilation. Intensive care unit admission is often required for patients with multiorgan involvement, where continuous hemodynamic monitoring, advanced ventilatory strategies, and organ support can be provided [42][43][44].

Symptom management is a critical component of treatment planning, both for reducing patient distress and for preventing complications

associated with uncontrolled symptoms. Fever control and analgesia are best achieved with acetaminophen (paracetamol), which provides antipyretic and analgesic effects without significantly affecting platelet function or increasing bleeding risk. Nonsteroidal anti-inflammatory drugs and aspirin should generally be avoided because they may exacerbate gastrointestinal irritation and potentiate hemorrhagic complications, particularly in the context of thrombocytopenia and coagulopathy. Nausea, vomiting, and diarrhea not only contribute to patient discomfort but also accelerate volume depletion and electrolyte imbalance. Antiemetic agents may be employed to alleviate nausea and vomiting, facilitating oral intake when feasible, while ongoing fluid and electrolyte replacement is paramount to prevent dehydration and hemodynamic compromise. Nutritional support should not be neglected; when oral intake is severely inadequate, enteral nutrition via a nasogastric tube or, if contraindicated, parenteral nutrition may be needed to maintain metabolic demands during the acute phase. Coagulation abnormalities demand particularly close attention. Marburg virus disease frequently induces disseminated intravascular coagulation, characterized by consumption of clotting factors and platelets alongside widespread microthrombi. Serial assessment of coagulation parameters—such as prothrombin time, activated partial thromboplastin time, fibrinogen levels, and D-dimer—along with platelet counts provides insight into the severity and progression of coagulopathy. In patients with significant bleeding or critically low platelet counts, transfusion of packed red blood cells, platelets, fresh frozen plasma, or cryoprecipitate may be indicated. These interventions must be individualized, balancing the need to correct hemostatic defects with the risk of volume overload and transfusion-related complications. Early recognition and management of hemorrhagic manifestations, including mucosal bleeding, gastrointestinal hemorrhage, and bleeding at venipuncture sites, are essential to mitigate the risk of fatal exsanguination [43][44].

Parallel to supportive care, there is growing interest in the integration of experimental and investigational therapies into treatment planning, particularly in specialized or research-oriented settings. Although no antiviral drug has yet gained formal approval for Marburg virus disease, several agents with promising preclinical data are being evaluated. Remdesivir, a broad-spectrum nucleotide analog, has demonstrated activity against several RNA viruses and has shown some protective effects in animal models of MARV infection. Favipiravir, a synthetic guanidine nucleoside, has also been tested in nonhuman primate models. Galidesivir (BCX4430), a nucleoside analog that targets viral RNA-dependent RNA polymerase, has yielded particularly encouraging results in animal studies, where early post-exposure administration markedly improved survival. Monoclonal antibodies directed against the Marburg glycoprotein, such as MR191-N and related constructs, represent another promising therapeutic avenue. By binding viral glycoproteins, these antibodies can neutralize circulating virus and facilitate clearance, as demonstrated in nonhuman primates where high survival rates were observed even when treatment was initiated after symptom onset. At present, the use of these agents in humans is largely limited to clinical trials or emergency compassionate-use protocols, and their incorporation into routine treatment strategies awaits further evidence of efficacy and safety. Convalescent plasma therapy, which involves transfusion of plasma collected from individuals who have recovered from Marburg virus disease, offers a form of passive immunotherapy by transferring polyclonal antibodies that may neutralize the virus. Historically, convalescent plasma and serum have been used in various viral hemorrhagic fevers, with mixed outcomes. Successful implementation requires careful donor screening, compatibility testing, and rigorous evaluation for bloodborne pathogens. While convalescent plasma therapy holds theoretical promise, especially in resource-limited outbreak settings, evidence specific to Marburg virus disease remains limited, and this modality should be approached as adjunctive and investigational rather than definitive therapy [44].

Vaccine development constitutes a longer-term but crucial component of treatment and prevention planning. Several Marburg vaccine candidates have been engineered using platforms similar to those successfully deployed against Ebola virus, including recombinant vesicular stomatitis virus (rVSV) vectors and other viral vector–based approaches. Some candidates have advanced into early-phase clinical trials, demonstrating acceptable safety and immunogenicity; however, none have yet achieved widespread licensure or deployment. Vaccines may ultimately play a significant role in protecting high-risk groups, such as healthcare workers, laboratory personnel handling filoviruses, and populations in areas where MARV is endemic or emerging. Until then, vaccination strategies remain largely at the investigational and preparedness-planning stages. Treatment planning also requires meticulous daily monitoring to guide clinical decision-making and to anticipate complications before they become irreversible. Routine laboratory studies typically include a complete blood count to monitor leukocyte trends, lymphopenia, and thrombocytopenia; a comprehensive metabolic panel to track renal and hepatic function, electrolyte status, and metabolic abnormalities; and coagulation profiles to detect and follow the evolution of DIC. Serial assessments allow clinicians to tailor fluid therapy, adjust organ support, and time transfusions appropriately. Likewise, vital sign monitoring must

be frequent and structured. Blood pressure, heart rate, respiratory rate, temperature, and oxygen saturation should be closely followed, with any trends toward hypotension, tachycardia, hypoxia, or hypothermia prompting immediate reassessment of hemodynamic stability, infection status, and organ perfusion. Clinical monitoring should extend beyond vital signs and laboratory values to include careful observation for signs of hemorrhage and neurological deterioration. New or worsening petechiae, ecchymoses, mucosal bleeding, hematemesis, melena, or hematuria warrant urgent evaluation and may necessitate escalated transfusion support or adjustments in invasive procedures. Neurological changes—ranging from subtle confusion and agitation to seizures and coma—are critical indicators of disease progression and may necessitate additional imaging, intensified supportive measures, or adjustments in sedation and airway management. Comprehensive, multidisciplinary rounds that include physicians, nurses, pharmacists, and, when appropriate, infectious disease and critical care specialists foster a coordinated and dynamic approach to treatment adaptation [42][43][44].

Finally, no treatment plan for Marburg virus disease is complete without robust infection control and public health measures. Once a case is suspected or confirmed, contact tracing must be initiated immediately to identify individuals at risk through close contact with the patient, including family members, caregivers, healthcare workers, and others with potential exposure to infectious bodily fluids. Identified contacts should be monitored for the duration of the incubation period, typically up to 21 days, with daily temperature checks and symptom assessments. Depending on the risk level, quarantine or movement restrictions may be recommended to reduce the likelihood of onward transmission. Safe burial practices constitute another critical component of infection control. Because viral shedding persists after death, handling of bodies must be performed using full PPE, and traditional practices involving direct contact with the corpse must be modified or replaced with safer alternatives through community engagement and culturally sensitive communication. Education of healthcare workers and communities is indispensable. Clinicians and staff must be trained in the correct use of PPE, waste disposal, and decontamination procedures. At the community level, public health messaging should emphasize the importance of avoiding contact with bats and other wildlife known to harbor MARV, discouraging the consumption of bushmeat, and encouraging prompt medical evaluation for febrile illness following high-risk exposures. Effective communication campaigns build trust, combat misinformation, and support adherence to public health recommendations, thereby complementing clinical efforts and maximizing the impact of treatment planning. In summary, treatment planning for Marburg virus disease is a complex, resource-intensive process that integrates isolation, advanced supportive care, judicious consideration of investigational therapies, continuous clinical and laboratory monitoring, and comprehensive infection control and public health strategies. While specific antiviral and immunotherapeutic options are still under development, current best practice focuses on optimizing supportive management and preventing secondary transmission. Through meticulous planning and coordinated multidisciplinary action, it is possible to improve survival and mitigate the broader societal impact of this highly lethal infection [44].

**Prognosis**

The prognosis of Marburg virus disease (MVD) remains guarded and typically poor, primarily because there is still no approved pathogen-specific therapy and management is limited to supportive care.[16] Case-fatality rates in documented outbreaks have frequently ranged from 24% to over 80%, depending on viral strain, healthcare capacity, and the timeliness of intervention. Optimal outcomes are more likely when patients are managed in specialized high-level biocontainment or filovirus treatment units, where experienced teams can provide intensive organ support, continuous monitoring, and rigorous infection control.[16] Early recognition and rapid initiation of supportive measures, including aggressive fluid resuscitation, correction of electrolyte disturbances, hemodynamic support, and transfusion of blood products when needed, are central to improving survival chances. The World Health Organization has issued detailed infection prevention and control (IPC) guidelines that should be activated as soon as MVD is suspected, not only to protect healthcare personnel and contacts but also to stabilize the healthcare environment in which critically ill patients are treated.[15] All staff with direct patient contact must adhere strictly to appropriate use of personal protective equipment (PPE), meticulous hand hygiene, and minimal use of needles and sharps to reduce the risk of occupational infection and preserve workforce capacity during outbreaks.[15] Prognosis at the population level is influenced by many variables, including access to advanced supportive care, the infectious dose, the route of exposure, the virulence of the circulating strain, comorbidities, and the baseline health and nutritional status of the affected community. Areas with limited healthcare infrastructure, poor baseline health indicators, and delays in outbreak detection often report higher mortality. Until effective antivirals or vaccines become widely available, improvements in prognosis will largely depend on strengthening health systems, enhancing IPC implementation, and ensuring rapid deployment of

expert clinical teams and resources during outbreaks [15][16].

**Complications**

Marburg virus disease is associated with a broad spectrum of severe and often life-threatening complications, most of which reflect the combined effects of uncontrolled viral replication, dysregulated host immune responses, and profound coagulopathy. Clinically, patients may progress from nonspecific febrile illness to the full picture of viral hemorrhagic fever, characterized by mucosal and gastrointestinal bleeding, petechiae, ecchymoses, and hemorrhage at venipuncture or injection sites. Disseminated intravascular coagulation contributes to both microvascular thrombosis and increased bleeding risk, frequently culminating in multiorgan failure and shock. Hepatic dysfunction, acute kidney injury, and respiratory compromise are common, particularly in the second week of illness, and together significantly increase mortality risk. Transmission to others constitutes an additional "complication" in the broader public health sense. Because MARV is present at high titers in blood and body fluids during acute illness and even after death, inadequate infection control in healthcare facilities or in the community can precipitate secondary cases and amplify outbreaks. For this reason, robust measures such as active surveillance, early isolation, contact tracing, avoidance of direct contact with sick individuals and their secretions, and strict adherence to PPE protocols are indispensable. These precautions extend to the handling of corpses, where improper burial practices have historically contributed to continued transmission. Furthermore, MARV-induced immunosuppression predisposes patients to secondary bacterial or fungal infections, which can complicate the clinical course and obscure the primary diagnosis. Secondary infections should therefore be actively considered and treated according to local antimicrobial resistance patterns and clinical judgment. Survivors may experience prolonged convalescence with residual fatigue, neurocognitive symptoms, and potential viral persistence in immune-privileged sites, raising concerns about delayed complications and, in rare cases, late transmission. Timely recognition, careful monitoring, and early intervention for complications are essential components of effective MVD management [15][16].

**Consultations**

The management of a patient with confirmed or suspected Marburg virus disease inevitably requires a coordinated, multidisciplinary approach. Infectious disease specialists play a central role in guiding diagnostic strategies, interpreting evolving evidence on investigational therapies, and shaping clinical management protocols tailored to filoviral infection. Microbiologists and virologists are essential for overseeing safe specimen handling, coordinating RT-PCR and other specialized testing, and ensuring that laboratory procedures meet the highest biosafety standards. Internal medicine physicians and critical care teams provide frontline management of hemodynamic instability, respiratory failure, renal dysfunction, and other organ-specific complications that are frequently encountered during the course of MVD. Pharmacists also form a critical part of the consultation network, particularly as investigational antivirals, monoclonal antibodies, and adjunctive therapies are considered. They assist in reviewing emerging data, ensuring appropriate dosing and monitoring of experimental drugs, and identifying potential drug–drug interactions or toxicity. In addition, hospital epidemiologists and infection control practitioners help design and enforce biocontainment measures, PPE protocols, and staff monitoring programs to prevent nosocomial spread. Beyond the hospital, early engagement of local and national public health authorities is essential. Departments of Public Health coordinate contact tracing, surveillance, risk communication, and community-level interventions. At the international level, agencies such as the World Health Organization (WHO), the United States Centers for Disease Control and Prevention (CDC), the Africa Centres for Disease Control and Prevention, the UK Health Security Agency, and other regional bodies provide technical guidance, on-the-ground support, mobile laboratory capacity, and logistical assistance. These organizations can help mobilize international resources, deploy specialized filovirus response teams, and harmonize cross-border containment efforts. Prompt consultation with these entities facilitates rapid implementation of appropriate control measures and contributes to mitigating both the clinical and public health impact of Marburg virus disease [15][16][17].

**Patient Education**

Deterrence of Marburg virus disease relies heavily on effective patient and community education, particularly among populations living in, working in, or traveling to endemic or at-risk regions. Individuals should be informed about the ecological niche of MARV, with emphasis on the role of fruit bats, particularly *Rousettus aegyptiacus*, as the principal reservoir. Public health messaging should encourage avoidance of caves and mines inhabited by bats, refrain from handling bats or other wildlife, and discourage consumption of bushmeat, especially in areas where filovirus circulation has been documented. Travelers to endemic regions should receive pre-travel counseling about the signs and symptoms of MVD, the importance of early medical evaluation for febrile illness, and appropriate behaviors to reduce exposure risk. Education must also address what actions to take if illness develops. Clear instructions regarding prompt self-isolation, avoidance of close physical contact with household members, and immediate notification of local health services are crucial once symptoms appear. In

outbreak settings, quarantine and movement restrictions for exposed individuals may be necessary, and these measures should be accompanied by transparent communication to maintain public trust, adherence, and psychological well-being. Patients and families should understand that isolation and quarantine are protective strategies for the community rather than punitive measures. For healthcare workers and caregivers, targeted training on recognition of MVD, correct use of PPE, and safe handling of blood and body fluids is essential. Educational initiatives should be culturally sensitive, multilingual where appropriate, and incorporate trusted community leaders and organizations to improve reach and acceptance. Ultimately, effective deterrence and patient education efforts not only reduce primary infections through behavior change but also facilitate earlier diagnosis and containment when cases do occur, thereby mitigating the overall impact of Marburg virus disease [1][3][5].

**Other Issues**

Experience from prior Marburg virus disease outbreaks has yielded several practical "pearls" that can greatly influence containment and clinical outcomes. Historically, most outbreaks have been controlled through the concerted efforts of local governments, public health departments, and international organizations such as the WHO and CDC.[29] Core strategies include rapid case identification, rigorous contact tracing, and active surveillance to detect secondary cases early. These measures are supported by comprehensive infection prevention and control interventions within healthcare facilities and the broader community.[29] At the individual level, strict avoidance of direct physical contact with symptomatic persons and their body fluids is fundamental. This extends to family caregivers, healthcare personnel, and those involved in funeral rituals. Proper hand hygiene—using alcohol-based hand rubs or soap and water—remains one of the most simple yet effective interventions to reduce transmission. Routine use of PPE, including gowns, gloves, masks, face shields, and goggles, is essential whenever there is a risk of exposure to blood or other potentially infectious materials. Patient transport within or between facilities should occur under controlled conditions, with pre-planned routes and protocols to minimize environmental contamination and staff exposure. Management of corpses is a critical issue. Bodies of deceased MVD patients remain highly infectious, and unsafe burial practices have been implicated in sustained transmission during earlier filovirus outbreaks. Safe burial protocols should therefore be implemented, including the use of PPE, avoidance of direct body contact, and, when acceptable, modified rituals that maintain cultural respect while ensuring safety. Aerosol-generating procedures, such as intubation or bronchoscopy, should be performed only when absolutely necessary and preferably in airborne isolation rooms using respiratory protection and full PPE.[29] Given the high case-fatality rate and potential for rapid spread, Marburg virus disease is a recognized global public health threat. Early suspicion, rapid diagnostic evaluation, and prompt initiation of supportive care can improve individual outcomes. Healthcare workers must maintain a high index of suspicion, particularly when encountering febrile patients with relevant travel or exposure history. Institutions should have predefined processes to trigger immediate infection control measures and alert public health authorities as soon as MVD is considered.[15] Robust national and global preparedness frameworks, including stockpiling of PPE, training of rapid response teams, and strengthening laboratory and surveillance systems, are indispensable for rapid, effective responses to future Marburg outbreaks [15][29].

**Enhancing Healthcare Team Outcomes**

Optimizing outcomes in Marburg virus disease hinges on effective interprofessional collaboration, continuous education, and robust systems-level support. Physicians and advanced practice clinicians are central in recognizing early clinical and epidemiologic signals suggestive of MVD, ordering appropriate diagnostics, and initiating evidence-based supportive care, including fluid management, organ support, and management of coagulopathy. Their role also extends to leadership in clinical decision-making, communication with families, and coordination with public health authorities. Nurses are equally critical; they provide continuous bedside monitoring, promptly detect changes in vital signs or mental status, administer medications and blood products, and ensure scrupulous adherence to infection prevention and control protocols, including the correct donning and doffing of PPE and maintenance of biocontainment practices. Pharmacists contribute by reviewing and managing medication regimens, especially when investigational antivirals, monoclonal antibodies, or adjunctive therapies are considered. They help ensure appropriate dosing, monitor for adverse effects, and keep the clinical team informed of evolving evidence on potential treatment options. Infection prevention specialists, hospital epidemiologists, respiratory therapists, and laboratory personnel also play indispensable roles in surveillance, environmental safety, respiratory support, and safe specimen handling. Strong, structured communication across the healthcare team is essential to minimize errors and maintain high standards of care. Regular multidisciplinary meetings, standardized handoffs, and clear protocols for escalation of care promote cohesion and shared situational awareness. When specialized biocontainment units are available, early transfer of patients into these settings can greatly facilitate coordinated management while reducing

risk to other hospital areas. Ongoing education and simulation-based training in filovirus management, PPE use, and emergency response ensure that staff remain prepared, confident, and competent as new research and guidelines emerge. By maintaining a unified, well-informed, and collaborative approach, interprofessional teams can maximize the quality and safety of care, reduce mortality, and limit the public health impact of Marburg virus disease. This model of teamwork—integrating clinical expertise, infection control, pharmacologic stewardship, and public health coordination—represents the cornerstone of effective response to high-consequence infectious diseases [15][16].

**Conclusion:**

In conclusion, Marburg virus disease remains a formidable global health threat due to its high pathogenicity, absence of specific therapeutics, and potential for explosive outbreaks, particularly in resource-limited settings. The clinical trajectory is rapidly progressive, with outcomes heavily dependent on early supportive care and rigorous infection control to prevent nosocomial spread. The cornerstone of containment lies in robust epidemiological surveillance and immediate public health action, including rapid case identification, exhaustive contact tracing, and community-based risk communication. Healthcare systems must prioritize preparedness through continuous training of personnel in correct PPE usage, establishment of isolation protocols, and ensuring adequate stocks of medical countermeasures. International collaboration and data sharing are critical, as evidenced by the role of organizations like the WHO and CDC in past outbreak responses. Furthermore, ongoing research into promising vaccine candidates and monoclonal antibodies offers hope for future prophylactic and therapeutic interventions. Ultimately, mitigating the impact of MVD requires a multi-faceted strategy that integrates advanced clinical management with decisive public health measures. Building resilient health infrastructure, fostering community trust, and maintaining a high index of suspicion among healthcare workers are essential to limit mortality and disrupt transmission chains during outbreaks.

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