

Tales of two outbreaks: Ebola and Hantavirus

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September 18, 2026

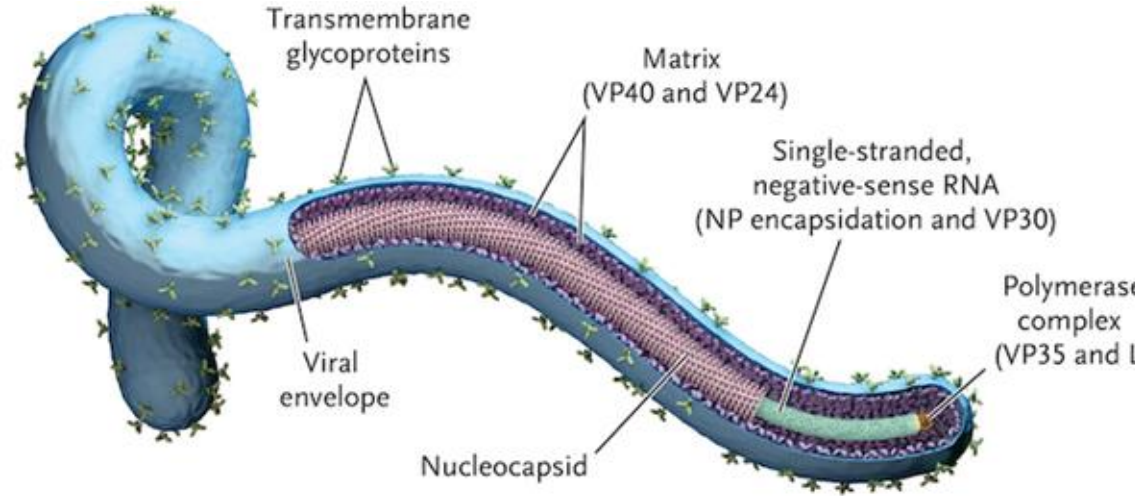
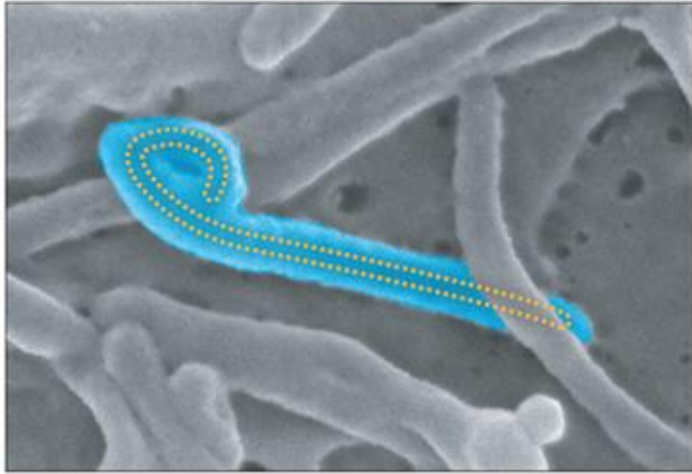
OBJECTIVES

1. Understand the clinical features, lab findings, diagnosis, and treatment of Hantavirus and Ebola
2. Understand the recommended screening and PPE for Ebola

Ebola

- Ebola disease was first identified in 1976, and there have subsequently been over 40 outbreaks
- Largest outbreak was the West African 2013-2016 Ebola virus disease (Zaire-Strain)
 - December 2013: in Guinea, a 2 year old develops bloody diarrhea and dies
 - Multiple family members, a nurse, and a midwife are infected
 - Midwife is from another village - infects multiple members of her family and staff at a district hospital
 - Staff subsequently infects their family members and more staff
 - Spreads to larger transportation centers and the outbreak exploded
 - 28,600 people infected, 11,325 died (~40% mortality rate)

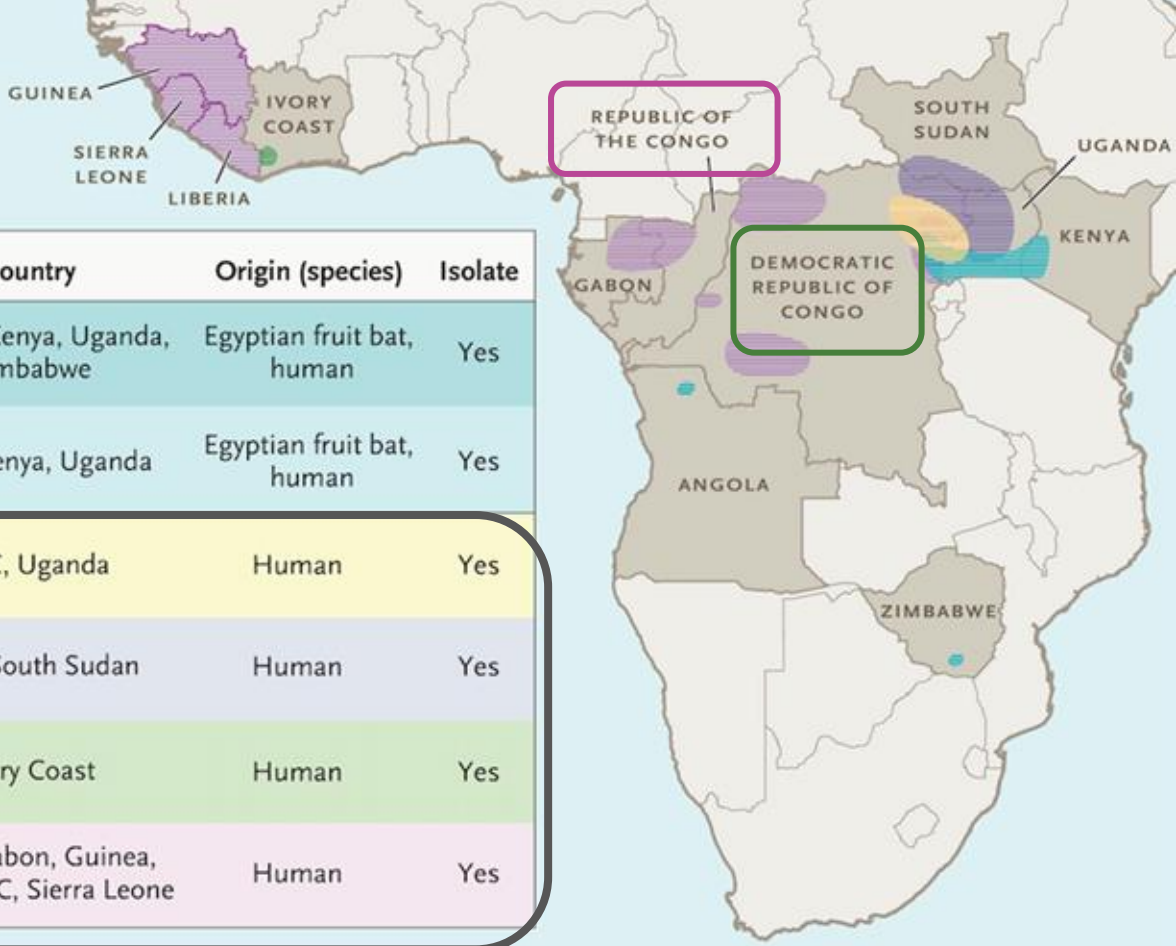
Ebola Virology



- Filovirus: enveloped, filamentous, nonsegmented, negative-sense-RNA virus

NEJM 2020;382:1832-1842

B Epidemiology and Taxonomy

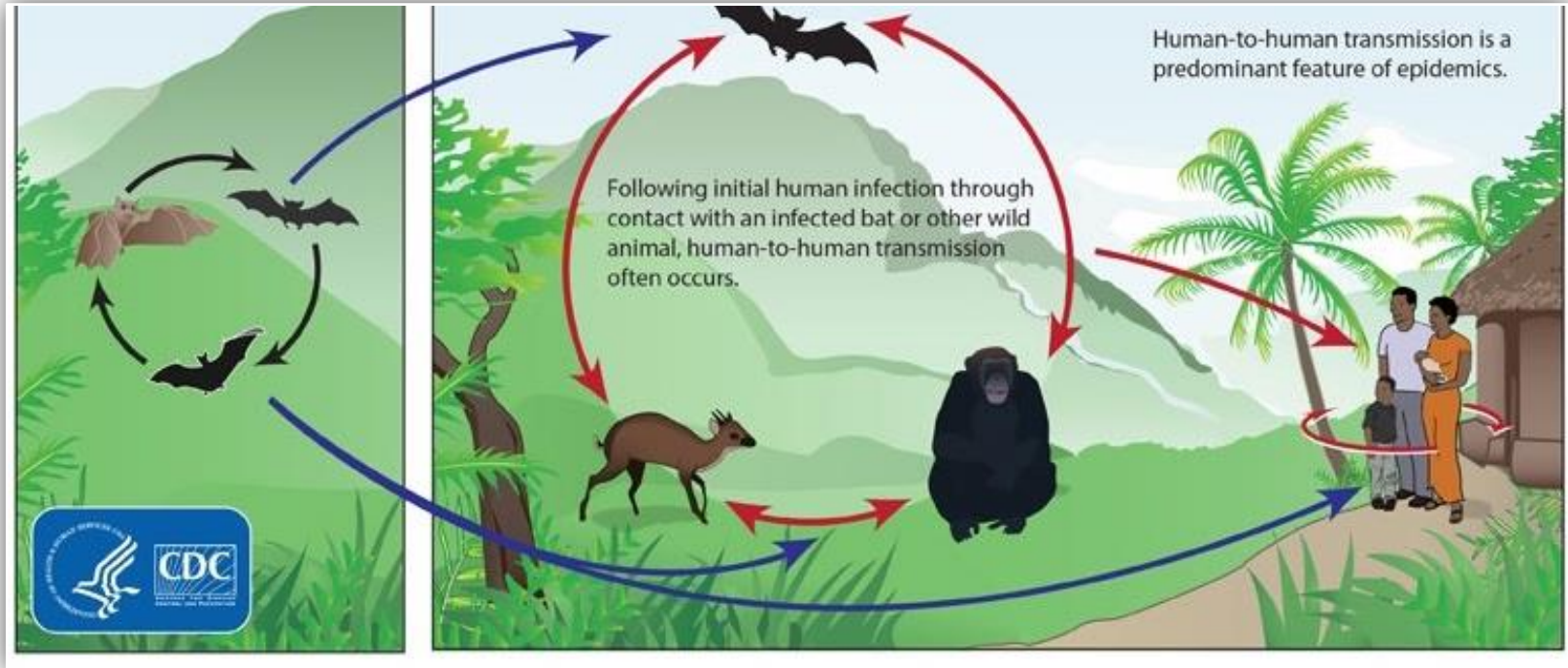


Genus	Species	Virus	Country	Origin (species)	Isolate
Marburgvirus	<i>Marburg marburgvirus</i>	Marburg virus (MARV)	Angola, Kenya, Uganda, Zimbabwe	Egyptian fruit bat, human	Yes
	<i>Marburg marburgvirus</i>	Ravn virus (RAVV)	DRC, Kenya, Uganda	Egyptian fruit bat, human	Yes
Ebolavirus	<i>Bundibugyo ebolavirus</i>	Bundibugyo virus (BDBV)	DRC, Uganda	Human	Yes
	<i>Sudan ebolavirus</i>	Sudan virus (SUDV)	DRC, South Sudan	Human	Yes
	<i>Tai Forest ebolavirus</i>	Tai Forest virus (TAFV)	Ivory Coast	Human	Yes
	<i>Zaire ebolavirus</i>	Ebola virus (EBOV)	DRC, Gabon, Guinea, Liberia, RC, Sierra Leone	Human	Yes

Bundibugyo Viral Disease

- Less severe illness than Ebola viral disease (EVD)
- Replicates less efficiently/rapidly than EVD
- Mortality of 25-50% (versus >70% for EVD)
- No approved therapeutics or vaccines

Where does Ebola come from?



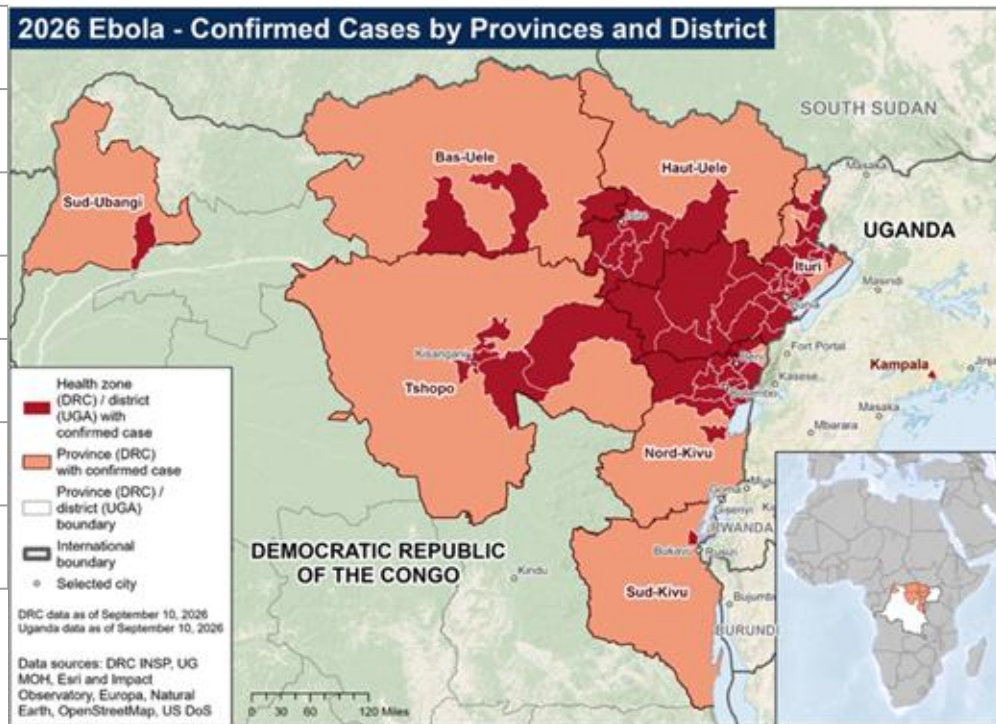
- Direct contact with vomit, diarrhea or blood on eyes, mouth, nasal passages, or broken skin
- Not spread through the air
- Less commonly through contaminated surfaces

Current Outbreak

- Weeks before 4/24, outbreak began in the Ituri Province of the Democratic Republic of the Congo
- 4/24 a nurse became ill with an Ebola-like illness, subsequently testing positive as the first confirmed case. 8 attending staff also developed compatible symptoms
- On May 5, the WHO was notified of a unknown illness with high mortality in Ituri Province, Democratic Republic of the Congo, including 4 health workers who died
- Testing, designed for Ebola viral disease, initially returned negative, but was subsequently confirmed as Bundibugyo viral disease.
- May 17 the WHO declared the outbreak a Public Health Emergency of International Concern.

Current Outbreak

DRC (as of 9/9)	6942 Confirmed Cases
	3349 Confirmed Deaths
Uganda (as of 9/10) last reported case 6/21	20 Confirmed Cases
	2 Confirmed Death
	1 Probable Case
	1 Probable Death
France (as of 9/10)	1 Confirmed Case



Current Outbreak

Ebola Bundibugyo virus disease, Democratic Republic of the Congo



Date and version of current assessment: 14 August 2026, v4

Date(s) and version(s) of previous assessment(s): 15 May 2026, V1; 22 May 2026, V2; 06 June 2026, V3

Overall risk and confidence¹

Overall risk			
Democratic Republic of the Congo	Countries sharing land borders with the Democratic Republic of the Congo	Rest of the African Region	Global
Very High	High	Low	Low

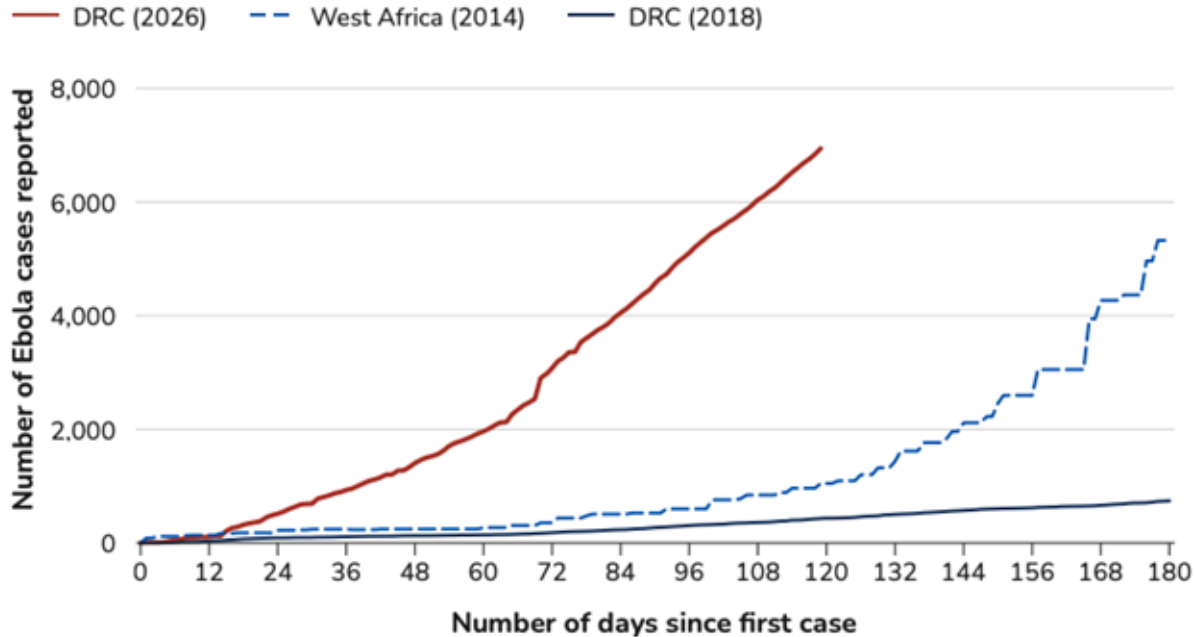
Confidence in available information			
Democratic Republic of the Congo	Countries sharing land borders with the Democratic Republic of the Congo	Rest of the African Region	Global
Moderate	Moderate	Moderate	High

Current Outbreak Concerns

- Already the 2nd largest Ebola outbreak in history
- Spreading substantially faster than previous outbreaks
- Occuring in a remote, resource poor area
- Occuring in an area of military conflict (M23 and Islamic State), population displacement (>2 million), mining and frequent movement of people for trade
- Violence against HCWs and shortages of PPE are leading to HCW infections
- Initial tests were for the Zaire Ebola Virus, and were falsely negative
- Limited experience with Bundibugyo virus outbreaks (this is only the 3rd), and vaccines and therapeutics are mostly for the Zaire Ebola Virus

Spreading Faster than Other Outbreaks

Cases in the first six months of Ebola outbreaks, 2014-2026



OPINION

COMMENTARY

Follow

The CDC Is Protecting Americans From Ebola

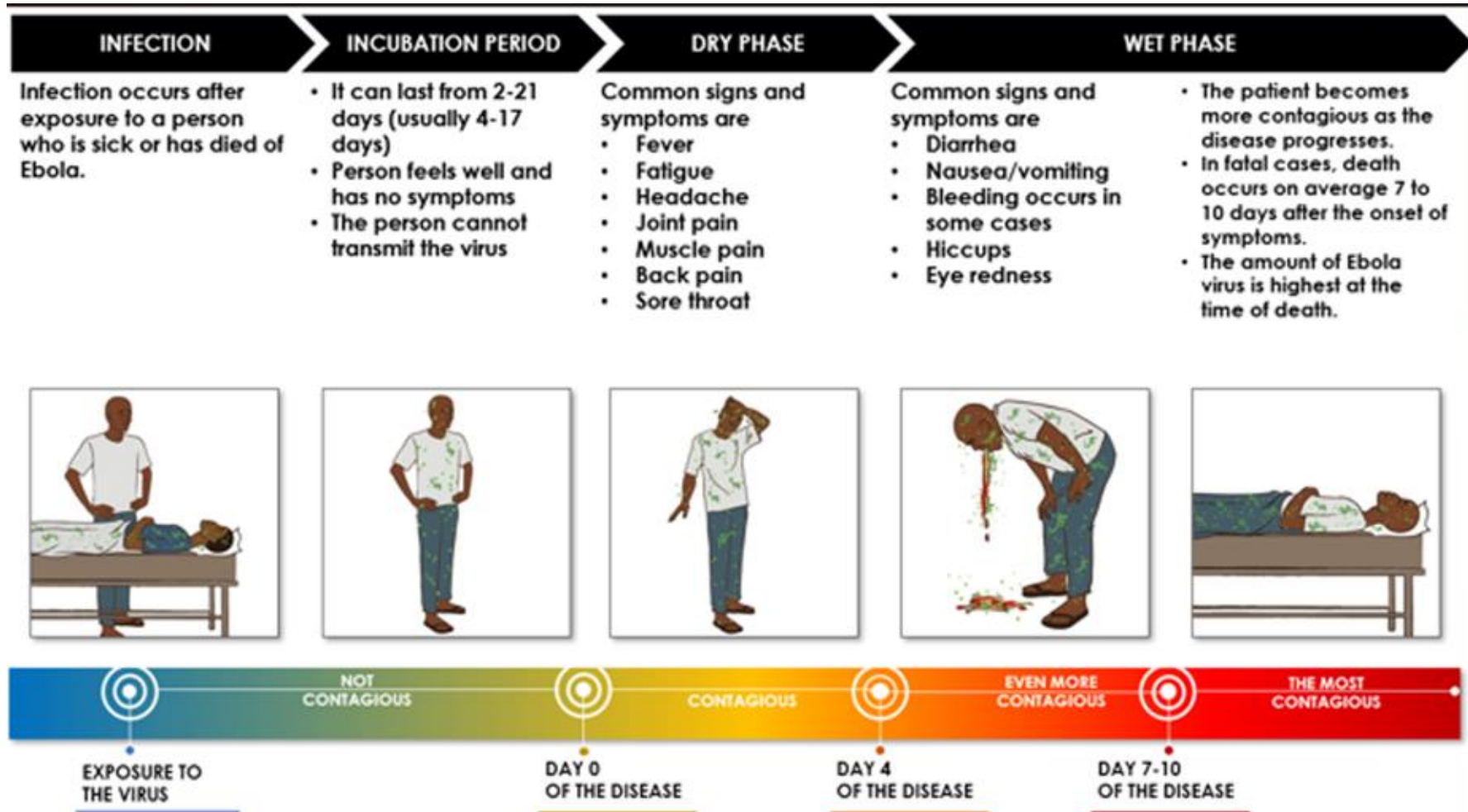
Unlike the Covid response, the CDC's measures are scientifically justified and tailored to containment.

By Jay Bhattacharya

June 3, 2026 at 4:57 pm ET

- Prevent importation of the virus into the US
- Provide care to Americans in the affected region - in Kenya
- Aid to the DRC

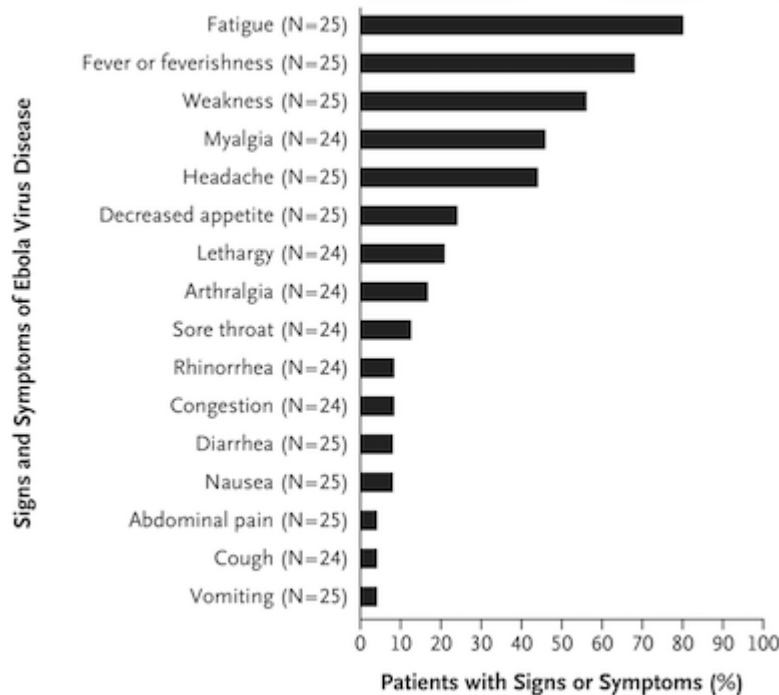
Ebola Clinical Features



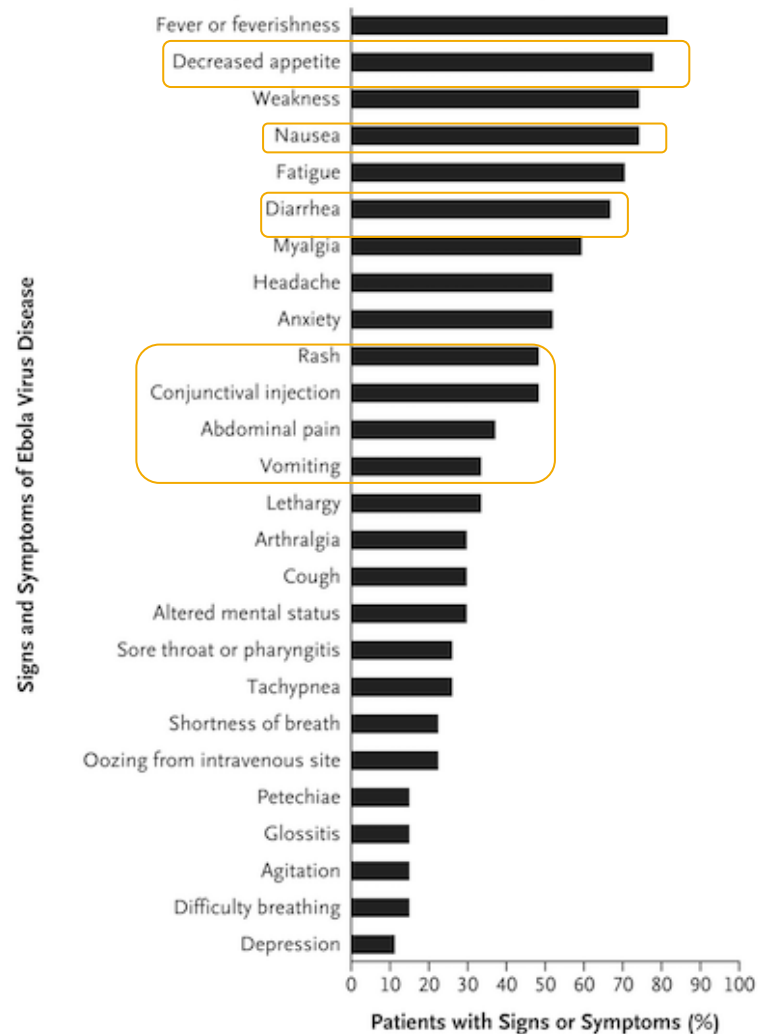
- In general, patients who will eventually pass from Ebola typically have more severe symptoms early in their illness
- Patients who will improve typically fever for about 6 days before improving
- Features are nonspecific and the differential diagnosis includes
 - **malaria**
 - dengue
 - typhoid,
 - Rickettsia
 - measles
 - leptospirosis
 - yellow fever
 - other viral hemorrhagic fevers (Marburg, Crimean-Congo hemorrhagic fever, Lassa fever, Rift Valley Fever)

Signs and Symptoms in US and European Ebola patients

A At the Onset of Illness



B At Admission to a Hospital in the United States or Europe



Clinical Course in US and European Patients

- Almost 50% had hypoxia
- All had diarrhea median 3 L of output/day (range 0.1 to 10 L/day)
- 33% had renal abnormalities
- 59% met SIRS criteria
- $\frac{1}{3}$ had either encephalopathy or encephalitis
- $\frac{1}{3}$ had evidence of bleeding diathesis (usually mild)
- Almost all received IV fluids
- 11% had malaria
- 14% received blood, 22% fresh frozen plasma, 18% platelets
- 70% received supplemental O₂; 15% non-invasive ventilation, 7% mechanical ventilation
- 19% dialyzed

Ebola Lab features and Diagnosis

Lab findings

- Leukopenia, frequently with lymphopenia, followed later by elevated neutrophils and a left shift
- Thrombocytopenia (50,000-100,000)
- Elevated amylase from pancreatic infection/inflammation
- Elevated transaminases (AST>ALT) - values may peak over 1,000 IU/L
- Proteinuria, elevated creatinine
- Electrolyte abnormalities from fluid shifts
- Prolonged PT, PTT and elevated fibrin degradation products - Disseminated Intravascular Coagulation (DIC)



- **Real-time Reverse Transcriptase Polymerase Chain Reaction (RT-PCR): Gold standard**
- Detects viral RNA in blood, plasma, serum, urine, oral fluid, or semen.
- Over 50 Laboratory Response Network (LRN) laboratories located throughout the United States.

Laboratory Confirmation

WHEN SPECIMENS SHOULD BE COLLECTED FOR EBOLA TESTING



Ebola virus is detected in blood only after the onset of symptoms, usually fever. It may take up to 3 days after symptoms appear for the virus to reach detectable levels. Virus is generally detectable by real-time RT-PCR from 3-10 days after symptoms appear.



Ideally, specimens should be taken when a symptomatic patient reports to a healthcare facility and is suspected of having an Ebola exposure. However, if the onset of symptoms is <3 days, a later specimen may be needed to completely rule-out Ebola virus, if the first specimen tests negative.

PREFERRED SPECIMENS FOR EBOLA TESTING

A minimum volume of 4 milliliters of whole blood preserved with EDTA is preferred for Ebola testing.



Specimens should be shipped frozen on dry ice.



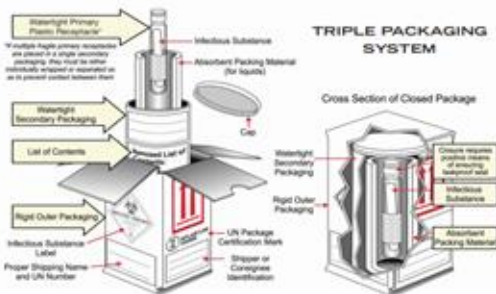
Do not submit specimens in glass containers to CDC.



Do not submit specimens preserved in heparin tubes.



PACKAGING & SHIPPING CLINICAL SPECIMENS



TRIPLE PACKAGING SYSTEM

Cross Section of Closed Package



INFORMATION ON SHIPPING & TRANSPORT

Waste Management

Handling VHF-Associated Waste

The handling, transport, treatment, and disposal of waste generated during the care of patients under evaluation or with confirmed VHF is subject to procedures set forth by local, state, and federal regulations.

Safe handling and in-hospital/clinic management of waste generated with care of patient with VHF is based on 3 principles

1. Safe containment and packaging of waste should be performed as close as possible to the point of generation. Staff should avoid opening containers to manipulate the waste after primary containment.
2. Limit the number of personnel entering the VHF patient care area and those handling generated waste before and after primary containment.
3. Always use appropriate personal protective equipment (PPE) and procedures for handling waste until onsite inactivation or transport away from the hospital for offsite inactivation.

Treatment and Prevention of Ebola

Supportive Care

Hypovolemia & Sepsis

- Aggressive IV fluid resuscitation
- Hemodynamic support & ICU care
- Volume Losses: 5-10L / day
- Look for and treat co-infections - malaria, bacteria

Electrolyte & Acid-Base

- Aggressive electrolyte repletion
- Correction of acid-base derangements

Symptomatic Management

- Manage fever & GI symptoms
- Avoid NSAIDs (bleeding risk)
- Antiemetics

Multisystem Organ Failure

- Oxygenation & mechanical ventilation
- Correction of severe coagulopathy
- Minimize invasive procedures
- Renal replacement therapy

WHO-Recommended Possible BVD Treatments or Prevention

- No proven or FDA approved therapeutics for BVD
- Possible treatments recommended by WHO for clinical trials
 - IV Remdesivir
 - Monoclonal Antibodies
 - MBP134
 - Maftivimab
- Possible Post-exposure prophylaxis
 - PO Obeldesivir
- Possible Vaccine Candidates
 - IAVI - rVSV Bundibugyo vaccine
 - Oxford/Serum Institute of India - ChAdOx1 Bundibugyo

<https://www.who.int/news/item/28-05-2026-experts-convened-by-who-advise-on-candidate-treatments-and-vaccines-for-ebola-disease-caused-by-bundibugyo-virus>

3 Key Principles for Ebola

- Identify
- Isolate
- Inform

Identify:
Travel and Exposure History
Symptoms Screening

CDC Interim Screening Guidelines- Questions

Nonoccupational

1. Exposure to a person with acute febrile illness
2. Visiting a health care facility or traditional healer
3. Attending a funeral or burial
4. Contact with bats, bat urine or droppings, or non-human primates; contact with blood, fluids, or raw meat from these animals; or entry into areas known to be inhabited by bats (e.g., caves, mines)

Occupational- High Risk

1. Providing health care, performing environmental cleaning, or handling of waste in an Ebola treatment unit (ETU), or for patients with BVD in any clinical setting
2. Entry into a patient care area of an ETU for any reason
3. Providing health care to an acutely ill patient not known to have BVD
4. Environmental cleaning or handling of waste in a regular healthcare facility
5. Clinical laboratory work associated with a treatment unit or other health care setting
6. Burial work

Isolate

Patient Isolation Protocols

mask

Step 1: Masking

Immediately place a mask on the patient to contain respiratory secretions.

meeting_room

Step 2: Private Room

Move the patient to a private room, preferably with an attached toilet and a door that can remain closed.

air

Step 3: Specialized Isolation

If an aerosol-generating procedure is anticipated, place in an Airborne Infection Isolation Room (AIIR/negative pressure room).

Inform

- Immediately notify
 - Infection prevention,
 - Unit and hospital leadership,
 - Local public health

Appropriate PPE for Healthcare Workers When Managing a Suspected or Confirmed Case

**PPE for suspected case
(Level 4 Gown)**



Cruise to the end of the world – Hantavirus

Hantaviral basics

- Zoonotic viral disease caused by *Orthohantavirus*
- Human infections primarily acquired through contact with urine, feces, saliva of rodents, or touching contaminated surfaces. Rare transmission through rodent bites or scratches. Rare cases of human to human transmission have been reported for the Andes strain
- 2 clinical syndromes - hantavirus pulmonary syndrome (HPS) and hemorrhagic fever with renal syndrome (HFRS)
- HFRS usually occurs in Europe and Asia (old world), although the milder Seoul virus is found worldwide, including the USA
- HPS found in the Americas (new world)



Hantavirus in the US

- Sin Nombre virus spread by rodents (classically the deer mouse)
- Disturbing fresh droppings can aerosolize the virus leading to airborne transmission
- Watch for this when spring cleaning, rural areas, spending time in forests, fields, farms, trash dumps
- Buzzwords: hoarder, house cleaning, rural cabins with mice

Hantavirus Cardiopulmonary Syndrome

- Prodrome phase of 2-8 days followed by a cardiopulmonary phase for 2-7 days
- Prodrome/febrile phase: acute onset fever, chills, myalgias, nausea, vomiting, weakness, diarrhea. HA, abdominal pain, cough
- Cardiopulmonary phase: rapid onset shock and non-cardiogenic pulmonary edema
- 38% mortality

Hantavirus

- Lab findings: thrombocytopenia, increased LDH, transaminitis, lactic acidosis. Can get leukocytosis (even to 90K!), marked immunoblasts
- Diagnostic triad: sudden appearance of thrombocytopenia, left shift, and immunoblasts >10%
- Hantavirus ELISA for IgM and IgG with confirmatory WB
- Immunostaining on path tissue (post-mortem) available
- PCR

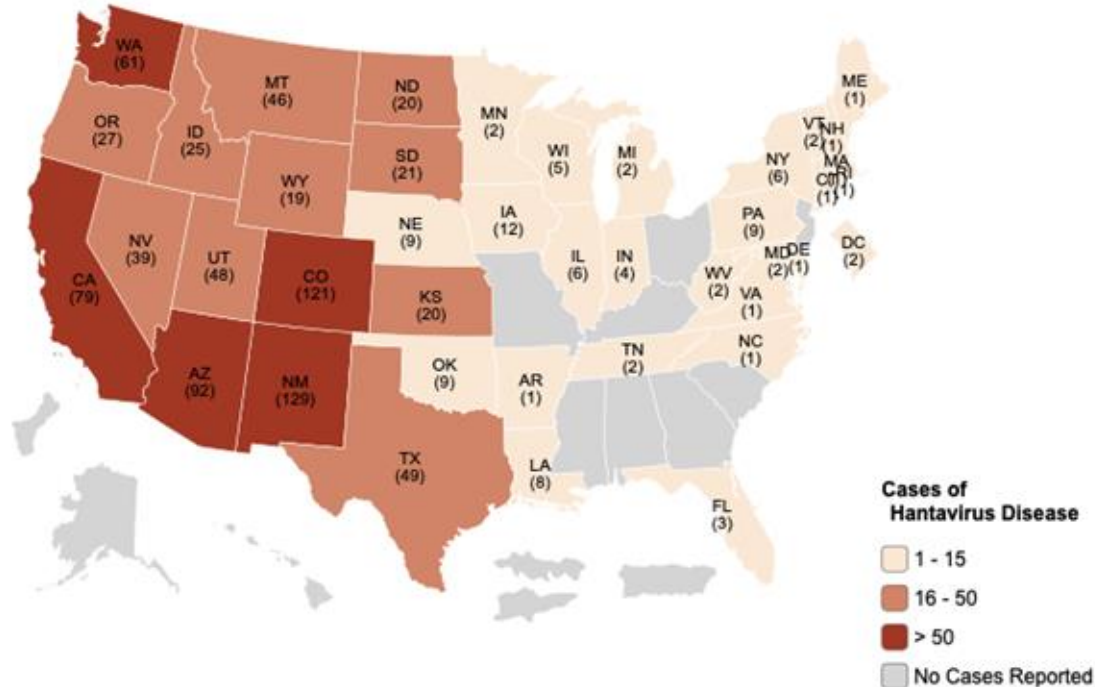
Treatment

- ICU level supportive care
- ECMO
- Ribavirin – some benefit for Hantaan virus, Andes, not for Sin nombre. Better studies needed
- Other antivirals – favipiravir, baloxavir, molnupiravir
- Convalescent plasma (50% mortality reduction in one study) and monoclonal antibodies (promise in hamster models)

Infection Prevention

- Eliminate rodent vectors and their feces
- Clean rodent infested areas with bleach while wearing N95 respiratory and eye protection under well ventilated conditions
- For Andes virus infections, airborne-infection isolation room (AIIR), gown, gloves, eye protection, N95
- Healthcare worker infections have occurred but are uncommon. Close contacts, intimate partners are at highest risk of transmission

Cumulative cases of hantavirus through 2023





m/v Hondius

HONDIOUS IS THE WORLD'S FIRST-REGISTERED POLAR CLASS 6 VESSEL AND WAS BUILT FROM THE GROUND UP FOR EXPEDITION CRUISING.



Cruise to the South Atlantic

- 4/1 cruise ship departed Argentina
- 4/3 respiratory symptoms developed in a passenger who passed away on 4/11 from respiratory failure. He had a 3-month history of travel to Argentina, Chile, and Uruguay prior to the cruise.
- Body removed from the ship at St. Helena on 4/24, along with his partner.
- Partner began to get sick 4/24 and tried to make her way back to the Netherlands via Johannesburg. She boarded a flight to Amsterdam, but was too sick to take off. Disembarked, collapsed in the airport and died in a Johannesburg ED 4/26
- 4/27 man evacuated to Ascension Island with respiratory failure, transferred to Johannesburg for ICU care, with shock, ARDS. Diagnostic workup was negative
- Samples from the third and later second patient tested positive for Hantavirus

- German national died on 5/2
- Two crew members, the ship's doctor and a tour guide were medically evacuated to the Netherlands on 5/7 and 8th
- Total of 13 cases tied to this outbreak, 3 deaths, giving a case fatality ratio of 23%
- All cases occurred amongst people on the ship
- Belief is acquired on land prior to the trip, with subsequent human to human transmission
- Contact tracing done on passenger and crew of the ship, contacts on Tristan Da Cunha, contacts on 2 different international flights, health care workers and airport crews. 317 contacts identified and quarantined/monitored; 336 low risk cases self-monitored

Andes virus

- Long incubation period - 6 to 8 weeks
- Secondary spread in 3% of contacts in one outbreak
- Some super-spreader events identified with large social gatherings and limited interaction
- Intimate partners at highest risk
- RNA vaccine being developed
- Outbreak declared over by WHO on 7/2

Thank you