Ebola (virus)

Ebola hemorrhagic fever

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Introduction

- The Ebola virus, or Ebola hemorrhagic fever, is a type of RNA virus that causes Ebola hemorrhagic fever.
- It is highly contagious and is often fatal in humans and some primates, like monkeys and gorillas.
- Ebola is transmitted through direct contact with the bodily fluids .
- It got its name from a river in Africa where it was first discovered in 1976.
- It has appeared from time to time since then.
- It was named after a river in the Democratic Republic of the Congo, which used to be Zaire, someone who is infected .

Subtypes of Ebola virus

- There are five identified subtypes of Ebola virus.
- four of the five have caused disease in humans:
- Ebola virus (*Zaire ebolavirus*)
- Sudan virus (*Sudan ebolavirus*)
- Taï Forest virus (*Taï Forest ebolavirus*, formerly *Côte d'Ivoire ebolavirus*)
- Bundibugyo virus (*Bundibugyo ebolavirus*)
- The fifth, Ebola-Reston, has caused disease in nonhuman primates.
- It is not known where the virus originated, but it did start with animals (zoonotic).
- The Ebola-Reston virus has its origin in cynomolgus monkeys that were imported to the United States and Italy from the Philippines.

MOLECULAR STRUCTURE

- Ebola virus is a member of a family of RNA viruses called the Filoviridae.
- Characterization of the virus
  - Order: Mononegavirales
  - Family: Filoviridae
  - Genus: Ebolavirus
  - Species: Ebola-Zaire, Ebola-Sudan, Ebola-Cote d-Ivoire, Ebola-Reston

Morphology under electron microscope

- filamentous, enveloped RNA virus approx. 19 kb in length (1 kb = 1000 RNA bases/nucleotides)

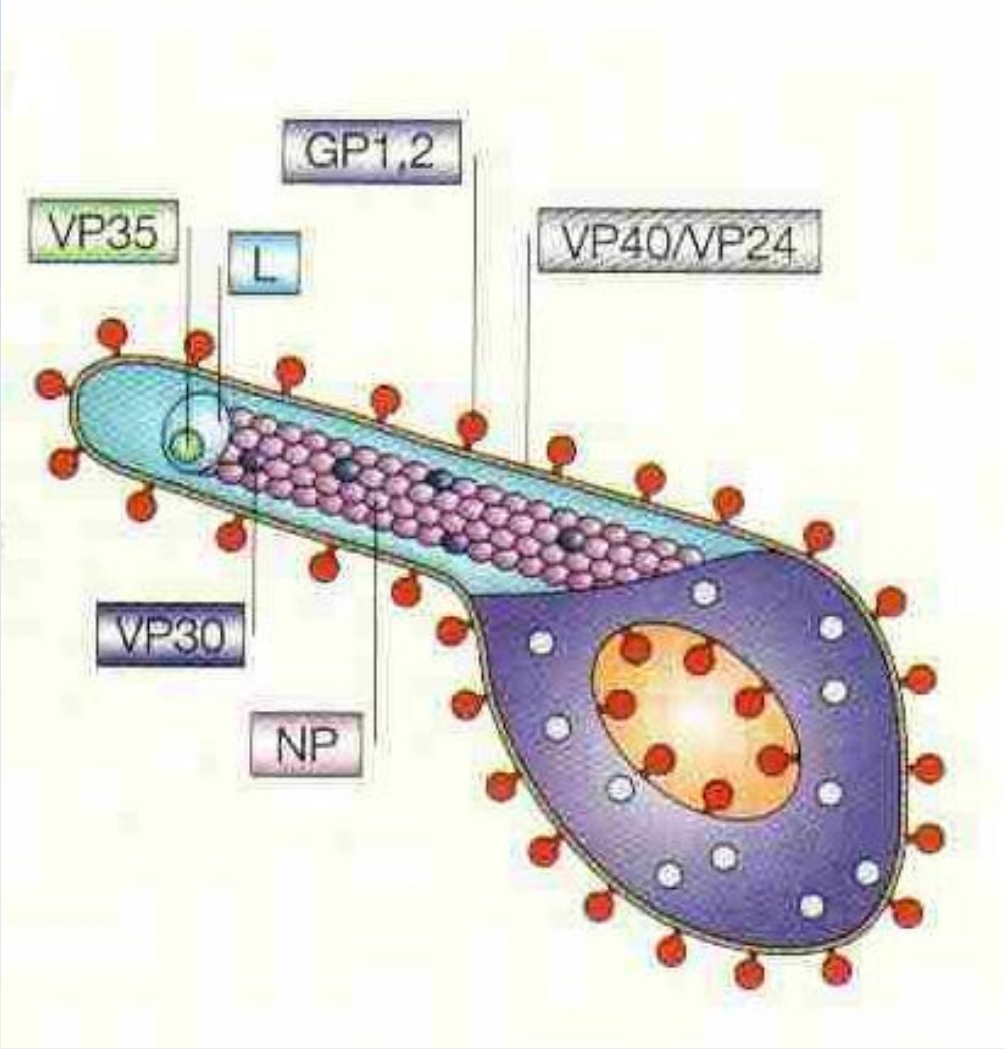
or 60-80 nm in diameter

- single-stranded, linear, non-segmented
- negative-sense RNA (encoded in a 3' to 5' direction)
- appears to have "spikes" due to glycoprotein on outside membrane

Structure of Ebola genome and proteins

- Transcribed into 8 sub-genomic mRNA proteins:
- 7 structural and 1 nonstructural .
- 7 structural proteins:
  - nucleoprotein (NP)
  - 4 viral/virion proteins (VP35, VP40, VP30, VP24)
  - glycoprotein (GP)
  - RNA-dependent RNA polymerase (L protein)
    - NP, VP35, VP30, L protein: required for transcription & replication
    - VP40, GP, VP24: associated with the membrane

Proteins



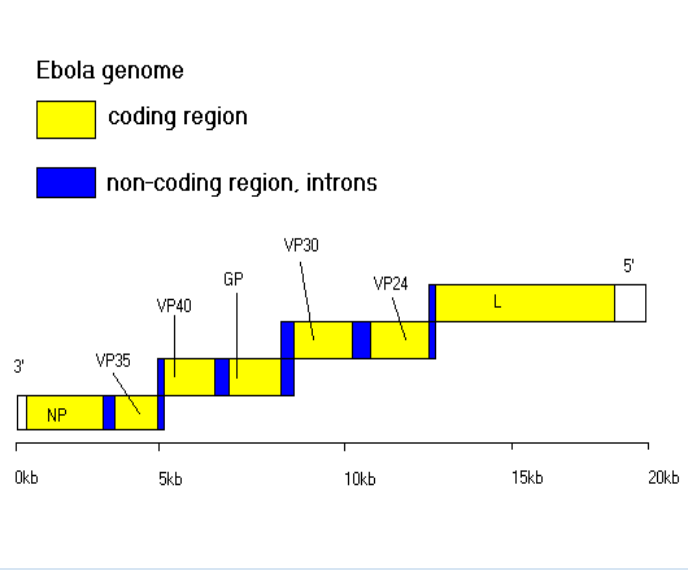
A depiction of the Ebola virus.

Ebola Pathogenesis

- Enters Bloodstream
  - skin, membranes,open wounds
- Cell Level
  - docks with cell membrane
- Viral RNA
  - released into cytoplasm
  - production new viral proteins/ genetic material
- New viral genomes
  - rapidly coated in protein
  - create cores

Ebola Pathogenesis, cont

- Viral cores
  - stack up in cell
  - migrate to the cell surface
  - produce trans-membrane proteins
  - push through cell surface
  - become enveloped by cell membrane



- ssRNA^{-} Genome Mutations
  - capable of rapid mutation
  - very adaptable to evade host defenses and environmental change

- Theory
  - virus evolved to occupy special niches in the wild

Clinical Observations

- **Incubation period:** 2-21 days

- **Stage I (unspecific):**
  -Extreme asthenia (body weakness)
  -diarrhea, nausea and vomiting, anorexia
  abdominal pain
  - headaches
  - arthralgia (neuralgic pain in joints)
  - myalgia (muscular pain or tenderness), back pain
  - mucosal redness of the oral cavity, dysphagia (difficulty in swallowing)
  - conjunctivitis.
  - rash all over body except in face

** If the patients don't recover gradually at this point, there is a high probability that the disease will progress to the second phase, resulting in complications which eventually lead to death (Mupapa et al., 1999).

Stage II (Specific):

- Hemorrhage
- neuropsychiatric abnormalities
- anuria (the absence of urine formation)
- hiccups
- tachypnea (rapid breathing).

** Patients who progressed to phase two EHF almost always die. (Ndambi et al., 1999)

Late Complications:

-Arthralgia
- ocular diseases (ocular pain, photophobia and hyperlacrimation)
- hearing loss
- unilateral orchitis(inflammation of one or both of the testes)

** These conditions are usually relieved with the treatment of 1% atropine and steroids

Diagnostic Tests

- Diagnosing Ebola in an person who has been infected for only a few days is difficult, because the early symptoms, such as fever, are nonspecific to Ebola infection and are seen often in patients with more commonly occurring diseases, such as malaria and typhoid fever.
- However, if a person has the early symptoms of Ebola and has had contact with the blood or body fluids of a person sick with Ebola, contact with objects that have been contaminated with the blood or body fluids of a person sick with Ebola, or contact with infected animals, they should be isolated and public health professionals notified.
- Samples from the patient can then be collected and tested to confirm infection.

Diagnostic Test

Laboratory tests used in diagnosis include:

Timeline of Infection	Diagnostic tests available
Within a few days after symptoms begin	1-Antigen-capture enzyme-linked immunosorbent assay (ELISA) testing 2-IgM ELISA 3-Polymerase chain reaction (PCR) 4-Virus isolation
Later in disease course or after recovery	1- IgM and IgG antibodies
Retrospectively in deceased patients	1- Immunohistochemistry testing 2- PCR 3- Virus isolation

Transmission

- Because the natural reservoir host of Ebola viruses has not yet been identified, the way in which the virus first appears in a human at the start of an outbreak is unknown.
- However, scientists believe that the first patient becomes infected through contact with an infected animal, such as a fruit bat or primate (apes and monkeys), which is called a spillover event.
- Person-to-person transmission follows and can lead to large numbers of affected people.
- In some past Ebola outbreaks, primates were also affected by Ebola, and multiple spillover events occurred when people touched or ate infected primates.

Transmission , cont.

- When an infection does occur in humans, the virus can be spread in several ways to others.
- Ebola is spread through direct contact (through broken skin or mucous membranes in, for example, the eyes, nose, or mouth) with blood or body fluids (including but not limited to urine, saliva, sweat, feces, vomit, breast milk, and semen) of a person who is sick with Ebola objects (like needles and syringes) that have been contaminated with the virus infected fruit bats or primates (apes and monkeys).

Transmission , cont.

- Ebola is not spread through the air or by water, or in general, by food.
- However, in Africa, Ebola may be spread as a result of handling bush meat (wild animals hunted for food) and contact with infected bats.
- There is no evidence that mosquitoes or other insects can transmit Ebola virus.
- Only a few species of mammals (for example, humans, bats, monkeys, and apes) have shown the ability to become infected with and spread Ebola virus.
- Healthcare providers caring for Ebola patients and the family and friends in close contact with Ebola patients are at the highest risk of getting sick because they may come in contact with infected blood or body fluids of sick patients.

Transmission , cont.

- During outbreaks of Ebola, the disease can spread quickly within healthcare settings (such as a clinic or hospital).
- Exposure to Ebola can occur in healthcare settings where hospital staff are not wearing appropriate protective equipment, including masks, gowns, and gloves and eye protection.
- Dedicated medical equipment (preferable disposable, when possible) should be used by healthcare personnel providing patient care.
- Proper cleaning and disposal of instruments, such as needles and syringes, is also important.
- If instruments are not disposable, they must be sterilized before being used again.
- Without adequate sterilization of the instruments, virus transmission can continue and amplify an outbreak.

Treatment

- No FDA-approved vaccine or medicine (e.g., antiviral drug) is available for Ebola.
- Symptoms of Ebola are treated as they appear.
- The following basic interventions, when used early, can significantly improve the chances of survival:
- Providing intravenous fluids (IV)and balancing electrolytes (body salts).
- Maintaining oxygen status and blood pressure
- Treating other infections if they occur

Treatment , cont.

- Experimental vaccines and treatments for Ebola are under development, but they have not yet been fully tested for safety or effectiveness.
- Recovery from Ebola depends on good supportive care and the patient's immune response.
- People who recover from Ebola infection develop antibodies that last for at least 10 years, possibly longer.
- It isn't known if people who recover are immune for life or if they can become infected with a different species of Ebola.
- Some people who have recovered from Ebola have developed long-term complications, such as joint and vision problems.

Prevention

- There is no FDA-approved vaccine available for Ebola.
- If you travel to or are in an area affected by an Ebola outbreak, make sure to do the following:
- Practice careful hygiene.
- For example, wash your hands with soap and water or an alcohol-based hand sanitizer and avoid contact with blood and body fluids.
- Do not handle items that may have come in contact with an infected person's blood or body fluids (such as clothes, bedding, needles, and medical equipment).

Prevention , cont.

- Avoid funeral or burial rituals that require handling the body of someone who has died from Ebola.
- Avoid contact with bats and nonhuman primates or blood, fluids, and raw meat prepared from these animals.
- Avoid hospitals in West Africa where Ebola patients are being treated.
- After you return, monitor your health for 21 days and seek medical care immediately if you develop symptoms of Ebola

Prevention , cont.

- Healthcare workers who may be exposed to people with Ebola should follow these steps:
- Wear protective clothing, including masks, gloves, gowns, and eye protection.
- Practice proper infection control and sterilization measures.

Prevention , cont.

- Isolate patients with Ebola from other patients.
- Avoid direct contact with the bodies of people who have died from Ebola.
- Notify health officials if you have had direct contact with the blood or body fluids, such as but not limited to, feces, saliva, urine, vomit, and semen of a person who is sick with Ebola.
- The virus can enter the body through broken skin or unprotected mucous membranes in, for example, the eyes, nose, or mouth .

- The Centers for Disease Control and Prevention, the CDC, has labeled the Ebola virus a Category “A” agent.
- This means that it could be a great threat to the public health and has the potential to spread rapidly.

Cases of Ebola Virus Disease in Africa, 1976 - 2014

Cases	Deaths	mortality	Species	Year
5481	2946	54 %	*Zaire ebolavirus*	2014
53	20	38 %	*Sudan ebolavirus* *Bundibugyo ebolavirus*	2012
413	52	13 %	*Bundibugyo ebolavirus* *Zaire ebolavirus*	2007
143	128	90 %	*Zaire ebolavirus*	2002
425	224	53 %	*Zaire ebolavirus*	2000
315	250	79 %	*Zaire ebolavirus*	1995
602	431	72 %	*Zaire ebolavirus* *Sudan ebolavirus*	1976