



Ebola Virus Disease

Mary Choi, MD, MPH

Viral Special Pathogens Branch

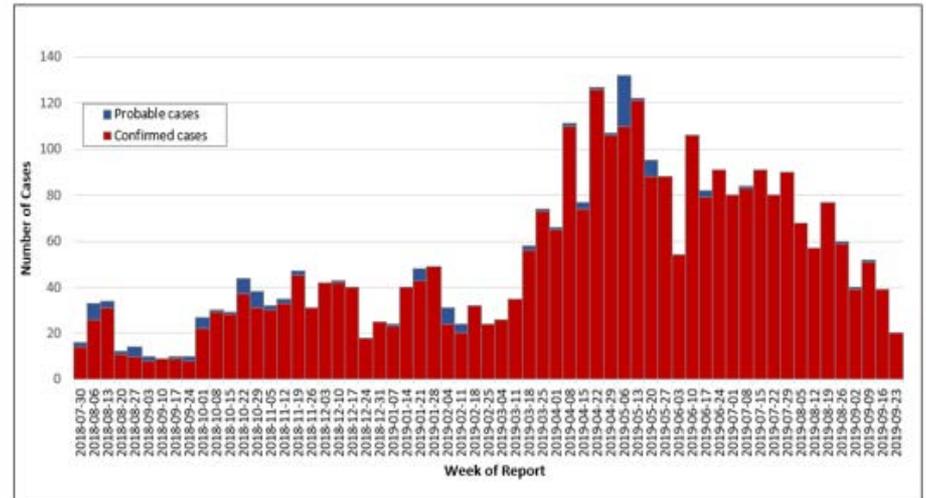
Centers for Disease Control and Prevention

Advisory Committee on Immunization Practices

October 23, 2019

Case Counts as of September 29, 2019

- Cases reported in 29 health zones; 3 provinces
- >3000 cases; >2000 deaths
- 165 healthcare workers infected



Background

- Ebola virus disease (EVD) is a deadly disease caused by infection with one of 4 viruses within the genus *Ebolavirus*, family *Filoviridae*
 - Ebola virus (*species Zaire ebolavirus*)
 - Sudan virus (*species Sudan ebolavirus*)
 - Tai Forest virus (*species Tai Forest ebolavirus*)
 - Bundibugyo virus (*species Bundibugyo ebolavirus*)
- Natural reservoir unknown; likely bats

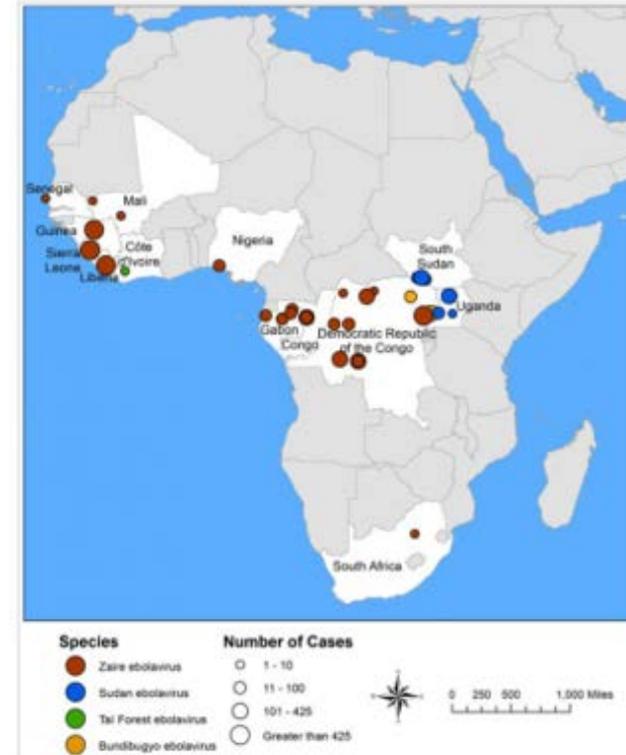
Background (continued)

- Ebola virus disease (EVD) is a deadly disease caused by infection with one of 4 viruses within the genus *Ebolavirus*, family *Filoviridae*
 - Ebola virus (*species Zaire ebolavirus*)
 - Sudan virus (*species Sudan ebolavirus*)
 - Tai Forest virus (*species Tai Forest ebolavirus*)
 - Bundibugyo virus (*species Bundibugyo ebolavirus*)

Ebola virus (species *Zaire ebolavirus*)

- Responsible for 18/28 (64%) of EVD outbreaks reported since 1976
 - 31,059 cases; 12,970 deaths*
- Two largest EVD outbreaks due to Ebola virus
 - 2014 West Africa outbreak
 - Current DRC outbreak
- Untreated, mortality rates 70-90%
 - Highest mortality rate amongst the 4 viruses within genus

Ebola Virus Outbreaks by Species and Size, Since 1976



*not including current DRC outbreak

Person-to-Person Transmission

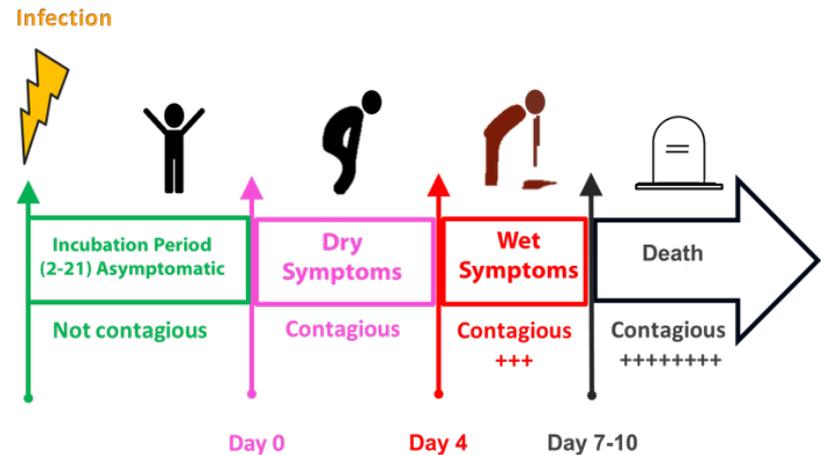
- Ebola virus can be found in all body fluids:
 - Blood
 - Feces/vomit
 - Urine
 - Tears
 - Saliva
 - Breast milk
 - Amniotic fluids
 - Vaginal secretions
 - Sweat
 - Semen
- Contact (through a break in skin, mouth, eyes, mucous membranes) with the body fluids of a person that is sick or has died of EVD.

Signs and Symptoms

- **Signs and symptoms of EVD include:**
 - Fever
 - Headache
 - Fatigue
 - Muscle pain/joint pain
 - Bleeding (epistaxis, injection sites)
 - Abdominal pain
 - Rash
 - Diarrhea
 - Vomiting
- **A person infected with Ebola virus is not contagious until symptoms appear**

Progression of EVD

- Wet symptoms develop ~ day 4 of illness
- Patient becomes increasingly contagious as the illness advances
- Without treatment, death usually occurs 7-10 days after illness onset
- Concentration of Ebola virus in the body is highest at the time of death



EVD Sequelae

- Incidence of sequelae amongst EVD survivors unknown
- Sequelae vary over time; most resolve over time
- Most commonly reported signs/symptoms:
 - 6 mo: Arthralgia, myalgia, abdominal pain, fatigue¹
 - 2 yr: uveitis, headache, joint pain, cataracts, muscle pain²
- Within one year of discharge, Ebola survivors had 5-fold greater mortality than the general population³
- Ebola virus persistence in immunoprivileged sites (e.g., testes, eyes, brain, placenta)

1. Rowe et al. Clinical, virologic, and immunologic follow-up of convalescent Ebola hemorrhagic fever patients and their household contacts, Kikwit, Democratic Republic of Congo

2. Preveil III Study Group. A longitudinal study of Ebola sequelae in Liberia

3. Keita et al. Subsequent mortality in survivors of Ebola virus disease in Guinea: a nationwide retrospective cohort study Lancet Infect Dis. 2019

Immunity

- Duration of natural immunity against Ebola virus in survivors unknown
 - Survivor found to have high levels of specific IgG antibodies to Ebola virus glycoprotein and neutralizing activity at 11 years¹ and 40 years after recovery²
 - Natural immunity postulated to be species specific
- Immune correlate for protection in humans against Ebola virus infection is unknown
- Protection due to a combination of humoral and cell-mediated immunity

¹ Corti et al. Protective monotherapy against lethal Ebola virus infection by a potently neutralizing antibody

² Ebola virus neutralizing antibodies detectable in survivors of the Yambuku, Zaire outbreak 40 years after infection

Treatment

- No FDA-approved treatments for EVD
- Early supportive care alone can significantly improve chances of survival ~40%
- In a randomized clinical control trial in DRC, Regeneron and mAB114 were found to reduce mortality to 29% - 34% respectively

Ebola Virus Disease in the United States

- 11 individuals treated for EVD in the United States
 - All associated with 2014-2016 West Africa EVD outbreak
 - 7/11: EVD diagnosed overseas, medically evacuated to the United States for care
 - 4/11: EVD diagnosis made in the United States
 - 2/11 (18%) died
- 1 imported case of EVD generated 2 secondary cases in the U.S.
 - Both secondary cases were nurses

Ebola Virus Disease in the United States (Continued)

- **11 EVD patients treated at five hospitals in the United States**
- **8/11 treatment initiated at Special Pathogen Treatment Centers (Emory, Nebraska, NIH, Bellevue)**
- **3/11 initially treated at community hospital; later transferred to special pathogen treatment centers**

Populations at Risk for EVD in the United States

- **Laboratory personnel who directly handle cultures/diagnostic samples/animals contaminated or infected with replication-competent Ebola virus**
- **Healthcare workers at U.S. Special Pathogen Treatment Centers caring for an EVD patient**
- **Personnel responding to an EVD outbreak**

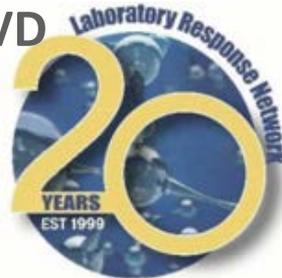
Biosafety Level 4 (BSL-4) Laboratory Personnel

- BLS-4 laboratories in the U.S ~350-400 lab and support staff
- Individuals who handle cultures/animals contaminated or infected with replication-competent Ebola virus for research purposes
- Individuals who handle diagnostic or clinical specimens containing replication-competent Ebola virus

CDC, GA	Galveston National Laboratory, TX
Georgia State, GA	Shope Laboratory, TX
NIH, MD	Texas Biomedical Research Institute, TX
USAMRIID, MD	Rocky Mountain Laboratories, MO
National Emerging Infectious Disease, MA	National Biodefense Analysis and Countermeasures Center, MD

Laboratory Response Network Personnel

- **Composed of local, state, federal public health, food testing, veterinary diagnostic, and environmental testing laboratories**
- **Affiliated with federal agencies, military installations, international partners, state/local public health departments**
- **57 LRN labs have the capacity to test for Ebola virus**
 - 37 labs have tested clinical samples collected from suspect EVD patients in the United States



Regional Treatment Network

- Developed in response to US EVD cases during 2014 West Africa Outbreak
- Nationwide regional treatment network for Ebola and other special pathogens

Type	Number	Role
Frontline healthcare facilities	4845	Has necessary materials/staff to care for suspect/confirmed EVD patient for at least 12 -24 hours
Ebola Assessment Hospital	217	Has necessary materials/staff to care for suspect/confirmed EVD patient for up to 96 hours
Ebola Treatment Center	63	Has necessary materials/staff to care for suspect/confirmed EVD patient for up to 7 days.
Regional Special Pathogen Center	10	Able to treat simultaneously at least two patients with Ebola for duration of illness

Special Pathogen Treatment Center Personnel

- 10 regional Special Pathogens Treatment Centers in the U.S. ~ 500 healthcare workers/support staff
- Specialized high-level isolation units equipped with infrastructure, laboratory capabilities, staff to care for patients with highly hazardous communicable diseases
- Able to treat simultaneously at least two patients with Ebola for duration of illness



Persons Responding to EVD Outbreaks

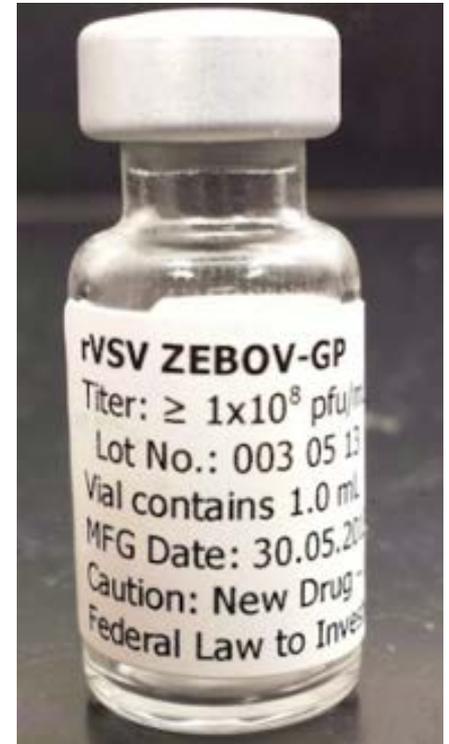
- Number of organizations responding to an outbreak will vary by size and location of the outbreak
- > 4,000 U.S. government personnel deployed to 2014 West Africa EVD outbreak (including domestic EVD cases)

¹ <https://www.cdc.gov/mmwr/volumes/65/su/pdfs/su6503.pdf> ³ <https://archive.defense.gov/news/newsarticle.aspx?id=123935>

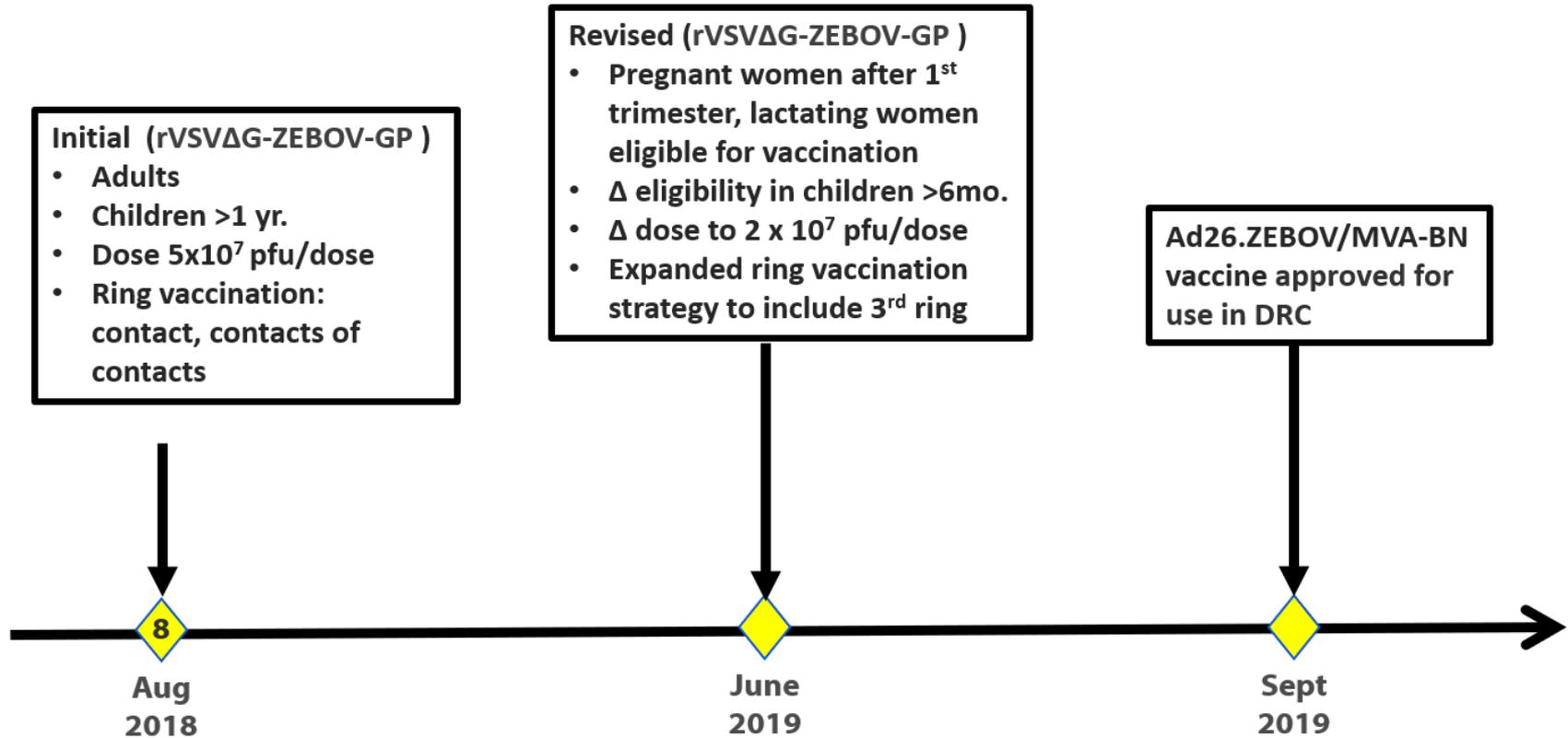
⁴Update on the U.S. Public Health Response to the Ebola Outbreak

Recombinant Vesicular Stomatitis Virus-Based Ebola Virus Vaccine (rVSVΔG-ZEBOV-GP)

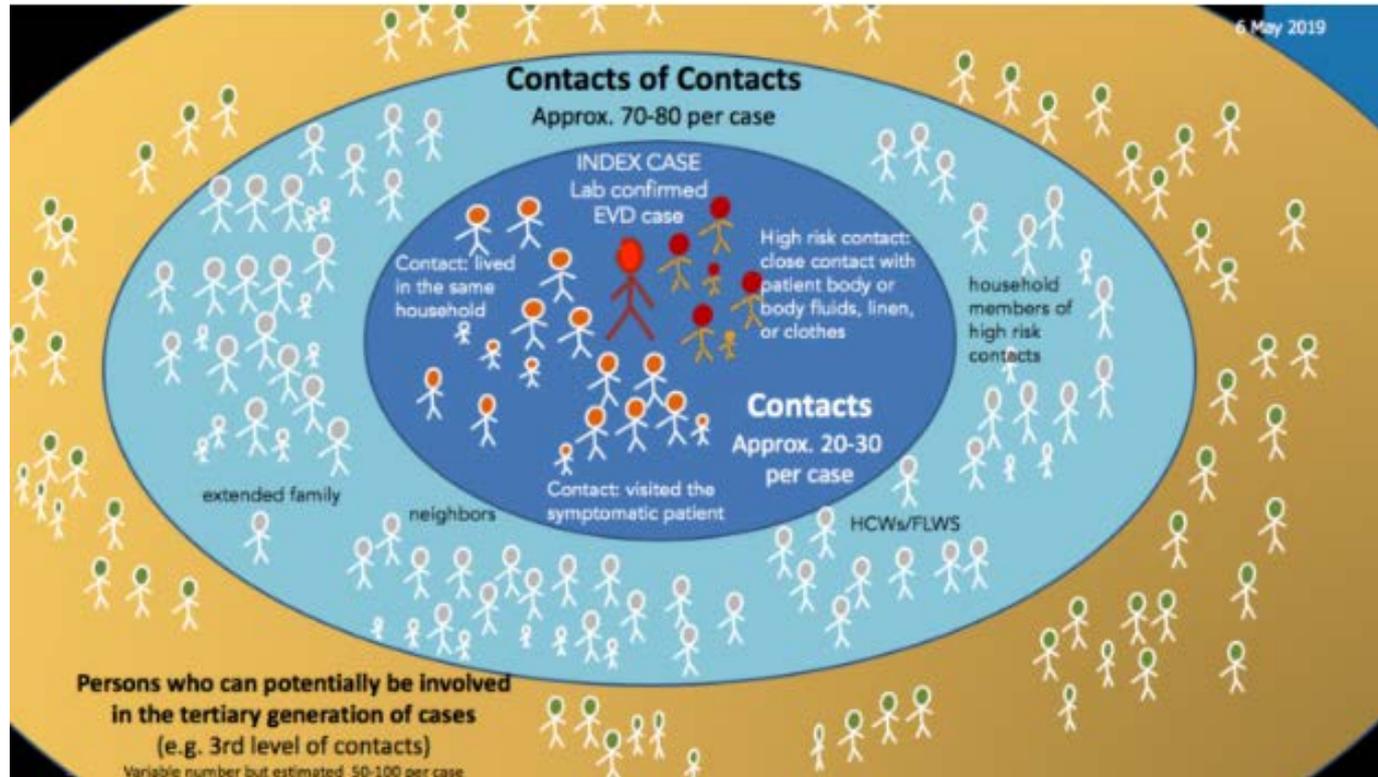
- **Live-attenuated recombinant vesicular stomatitis virus vaccine**
- **Initially developed by Public Health Agency Canada and New Link Genetics**
- **Merck currently holds intellectual rights**



Vaccination Strategy Eastern DRC EVD Outbreak



Ring Vaccination Strategy



Summary Slide

- Ebola virus (species *Zaire ebolavirus*) infection causes a severe disease with high morbidity and mortality
- Ebola virus responsible for 64% of EVD outbreaks; >31,000 infected; >12,000 deaths
- Current outbreak is the largest in DRC and is still ongoing
- US personnel at risk for occupational exposure
 - Laboratory personnel
 - Healthcare personnel at Special Pathogen Treatment Centers
 - Persons responding to EVD outbreaks

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

