The 2014 Ebola Outbreak and U.S. Airport Surveillance

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Confirmed, probable, and suspect cases and deaths from Ebola virus disease in Guinea, Liberia, and Sierra Leone, as of August 31, 2014

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The Name: Ebola

- 1976
- The first Ebolavirus species was discovered in what is now the Democratic Republic of the Congo near the Ebola River.
Ebola Hemorrhagic Fever (Ebola HF)

- One of numerous Viral Hemorrhagic Fevers.
- Family Filoviridae, genus Ebolavirus.

5 Identified Subspecies

- 4 of the 5 have caused disease in humans:
  - Ebola virus (Zaire ebolavirus);
  - Sudan virus (Sudan ebolavirus);
  - Tai Forest virus (Tai Forest ebolavirus, formerly Côte d'Ivoire ebolavirus);
  - Bundibugyo virus (Bundibugyo ebolavirus).

- Reston virus (Reston ebolavirus), has caused disease in nonhuman primates, but not in humans.

Natural Reservoir Host

- Unknown.
- Zoonotic (animal-borne)?
  - Bats?
    - Fruit bats of the Pteropodidae family
Transmission

- Hypothesis: 1st patient becomes infected through contact with an infected animal.
  - Bat?
  - Monkey?

- Human-to-human
  - 1) Direct contact with the blood or secretions of an infected person
  - 2) Exposure to objects (such as needles) that have been contaminated with infected secretions
Incubation Period

- 2 to 21 days after exposure
- 8-10 days is most common.

Early Symptoms

- Headache and fever are nonspecific
- Ebola cases may be initially misdiagnosed.

Typical Manifestations

- Fever
- Headache
- Joint and muscle aches
- Weakness
- Diarrhea
- Vomiting
- Stomach pain
- Lack of appetite
Additional Manifestations

- A Rash
- Conjunctival injection
- Hiccups
- Cough
- Sore throat

- Chest pain
- Dyspnea
- Difficulty swallowing
- Bleeding
  - Internal
  - External

Demographic characteristics and signs and symptoms for 56 case-patients who had laboratory-confirmed EHF, Bundibugyo District, Uganda, in 2007

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Case-patients confirmed by acute-phase sample, n = 43</th>
<th>Total no. confirmed case-patients, n = 56</th>
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<tbody>
<tr>
<td>Mean age, y (range)</td>
<td>33 (12–70)</td>
<td>37 (15–70)</td>
</tr>
<tr>
<td>Male sex (%)</td>
<td>16 (62)</td>
<td>30 (54)</td>
</tr>
<tr>
<td>Mean incubation period (d/95% CI)</td>
<td>5.7 (4.6–7.1)</td>
<td>6.3 (5.2–7.3)</td>
</tr>
<tr>
<td>Fever</td>
<td>26/26 (100)</td>
<td>55/55 (100)</td>
</tr>
<tr>
<td>Fatigue</td>
<td>22/23 (96)</td>
<td>49/50 (98)</td>
</tr>
<tr>
<td>Headache</td>
<td>21/25 (84)</td>
<td>48/53 (91)</td>
</tr>
<tr>
<td>Nausea/vomiting</td>
<td>24/26 (93)</td>
<td>48/54 (89)</td>
</tr>
<tr>
<td>Myalgia/myalgia</td>
<td>23/26 (90)</td>
<td>47/51 (88)</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>24/26 (93)</td>
<td>47/54 (87)</td>
</tr>
<tr>
<td>Anorexia/weight loss</td>
<td>20/21 (95)</td>
<td>44/51 (88)</td>
</tr>
<tr>
<td>Difficulty swallowing</td>
<td>16/22 (73)</td>
<td>27/51 (53)</td>
</tr>
<tr>
<td>Rash</td>
<td>8/26 (31)</td>
<td>25/54 (46)</td>
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<tr>
<td>Difficulty breathing</td>
<td>6/21 (29)</td>
<td>23/50 (46)</td>
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<td>Hiccups</td>
<td>6/23 (26)</td>
<td>16/51 (31)</td>
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<tr>
<td>Bleeding</td>
<td>11/26 (42)</td>
<td>36/56 (64)</td>
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Signs and symptoms, no. reporting/no. available (%)

- Black or bloody stool;
- Bloody vomitus;
- Hematuria
Ebola haemorrhagic fever in Zaire, 1976

- Both the incubation period, and the duration of the clinical disease averaged about one week.

- After 3-4 days of non-specific symptoms and signs, patients typically experienced progressively severe sore throat, developed a maculopapular rash, had intractable abdominal pain, and began to bleed from multiple sites, principally the gastrointestinal tract.

Mortality

- 60-90%

Timeline

- Initially present with general flu-like symptoms
- before a rapid progression to advanced disease characterized by hemorrhage, multiple organ failure and a shock-like syndrome
Highest risk?

- During outbreaks of Ebola HF
  - Health care workers
  - Family and friends of an infected individual.

Diagnostic Studies

- Within a few days after symptoms begin:
  - Antigen-capture enzyme-linked immunosorbent assay (ELISA) testing
  - IgM ELISA
  - Polymerase chain reaction (PCR)
  - Virus isolation

- Later in disease course or after recovery:
  - IgM and IgG antibodies

Standard Treatment

- Supportive therapy:
  - Balancing the patient's fluids and electrolytes
  - Maintaining their oxygen status and blood pressure
  - Treating any complicating infections

- Experimental treatments have been tested and proven effective in animal models
  - Not yet on humans.
Prevention

• No licensed specific treatment or vaccine is available for use in people or animals.

• Barrier nursing techniques
  – Wearing of protective clothing (such as masks, gloves, gowns, and goggles)
  – Use of infection-control measures (such as complete equipment sterilization and routine use of disinfectant)
  – Isolation of Ebola patients from contact with unprotected persons.

Ebola Surveillance in the United States
Purpose of U.S. Quarantine Stations

- Part of a comprehensive system that serves to limit the introduction and spread of contagious diseases in the United States.

- Located at 20 ports of entry and land-border crossings where international travelers arrive.

- Staffed with medical and public health officers from the CDC
  - Managed by CDC’s Division of Global Migration and Quarantine.
  - These health officers decide whether ill persons can enter the United States and what measures should be taken to prevent the spread of contagious diseases.

CDC’s Authority and Scope

- Legal authority to detain any person who may have an infectious disease that is specified by Executive Order to be quarantinable.

- If necessary, CDC can deny ill persons with these diseases entry to the United States.

- CDC also can have them admitted to a hospital or confined to a home for a certain amount of time to prevent the spread of disease.
Erika Sison

- An officer in the Public Health Service Commissioned Corps
  - Works for CDC
  - Degrees in chemistry and public health
  - Completing her doctorate in epidemiology at Rutgers

- The quarantine officer in charge at Newark Liberty International Airport
  - Part of the border security system at 18 airports and 2 border crossings.
  - Quarantine officers
    - Often not physicians
    - Make 2,000 health consultations a year with C.D.C. physicians about sick travelers

Erika’s Duties

- A one-bed isolation room in her office
- Trains border protection officers on the disease du jour, so they know when to call her.

- Ebola
  - Transmission is not airborne
  - Be alert for symptoms like fever, sweating and vomiting in travelers from West African countries like Sierra Leone, Liberia, Guinea and Nigeria.

Sierra Leone, Liberia, Guinea and Nigeria

- Less than 0.5% of the 243,000 international travelers US airports each day originate from those countries
  - An average of 679 from Nigeria
  - An average of 145 from the other three countries
Quarantinable Diseases by Executive Order

- Cholera
- Diphtheria
- Infectious tuberculosis
- Plague
- Smallpox
- Yellow fever
- Viral hemorrhagic fevers
- Severe acute respiratory syndromes
- New types of flu (influenza) that could cause a pandemic

Quarantine Station Response

- Respond to reports of illnesses on airplanes, maritime vessels, and at land-border crossings
- Distribute immunobiologics and investigational drugs
- Plan and prepare for emergency response

Donning PPE: List from first to last

- Gown
- Mask or respirator
- Goggles or face shield
- Gloves
Doffing PPE: List from first to last

- Gown
- Mask or respirator
- Goggles or face shield
- Gloves
Migration

• Monitor health and collect any medical information of new immigrants, refugees, asylees, and parolees
• Alert local health departments in the areas where refugees and immigrants resettle about any health issues that need follow up
• Provide travelers with essential health information
• Respond to mass migration emergencies

Inspection

• Inspect animals, animal products, and human remains that pose a potential threat to human health
• Screen cargo and hand-carried items for potential vectors of human infectious diseases

Partners

Partners

- Travel: Port officials, airlines, and cruise lines
- Medical: Emergency Medical Services, local and state public health departments, state public health laboratories, state and territorial epidemiologists, hospitals, and health care providers
- International: Canadian/Mexican border authorities, World Health Organization, Public Health Agency of Canada, overseas panel physicians, International Organization for Migration, and foreign governments

Kent Brantly, Nancy Writebol, and ZMAPP

Kent Brantly & Nancy Writebol: The Team

- 21 nurses
- 5 physicians
- Support staff: Hundreds.
- 26 gave direct patient care to these patients and no secondary infections
  - Used contact and droplet precautions
  - However, some of the nurses spending three to four hours in patients’ rooms were more comfortable wearing hoods than masks and face shields
Kent Brantly & Nancy Writebol: 
Lessons Learned
• Copious diarrhea and vomiting
• Electrolyte abnormalities
  — Low Sodium-Potassium
• Hepatic malfunction
  — Hypoproteinemia
  — Third-spacing
• Discharge instructions
  — No unprotected sex for three months.

Blood transfusion from a recovered patients
• No clue what role a blood transfusion could play.
• Not part of our standard treatment in USA
• No idea whether beneficial or detrimental.

Individuals that have recovered from Ebola virus infection
• WHO: May still be shedding Ebola nuclear material in semen in males and vaginal secretions in females
  — Potentially in urine.
• Discovered by doing assays looking specifically at the nuclear material of the virus.
• Unsure if this is viable virus that these individuals are shedding.
• Ebola survivors who were discharged and successfully resolved the infection
  — Follow-up several months later: There has never been any evidence that family members became infected.
Case Definition for Ebola Virus Disease (EVD)

- **Person Under Investigation (PUI)**
  - A person who has both consistent symptoms and risk factors as follows:
  - 1) Clinical criteria, which includes fever of greater than 38.6°C or 101.5°F, and additional symptoms such as severe headache, muscle pain, vomiting, diarrhea, abdominal pain, or unexplained hemorrhage; AND
  - 2) Epidemiologic risk factors within the past 21 days before the onset of symptoms, such as contact with blood or other body fluids or human remains of a patient known to have or suspected to have EVD; residence in—or travel to—an area where EVD transmission is active*; or direct handling of bats or non-human primates from disease-endemic areas.

- **Probable Case**
  - A PUI whose epidemiologic risk factors include high or low risk exposure(s)

- **Confirmed Case**
  - A case with laboratory-confirmed diagnostic evidence of Ebola virus infection

Exposure Risk Levels

- **High risk exposure**
  - Percutaneous (e.g., needle stick) or mucous membrane exposure to blood or body fluids of EVD patient
  - Direct skin contact with, or exposure to blood or body fluids of, an EVD patient without appropriate personal protective equipment (PPE)
  - Processing blood or body fluids of a confirmed EVD patient without appropriate PPE or standard biosecurity precautions
  - Direct contact with a dead body without appropriate PPE in a country where an EVD outbreak is occurring*

- **Low risk exposure**
  - Household contact with an EVD patient
  - Other close contact with EVD patients in health care facilities or community settings. Close contact is defined as:
    - Being within approximately 3 feet (1 meter) of an EVD patient or within the patient’s room or care area for a prolonged period of time (e.g., health care personnel, household members) while not wearing recommended personal protective equipment (e.g., standard, droplet, and contact precautions);
    - Having direct brief contact (e.g., shaking hands) with an EVD patient while not wearing recommended personal protective equipment.
  - Brief interactions, such as walking by a person or moving through a hospital; do not constitute close contact

- **No known exposure**
  - Having been in a country in which an EVD outbreak occurred within the past 21 days and having had no high or low risk exposures

Safe Management of Patients with Ebola Virus Disease (EVD) in U.S. Hospitals

- **Isolate the patient:** Patients should be isolated in a single patient room.
- **Wear appropriate PPE:** Healthcare providers entering the patients room should wear: gloves, gown (fluid resistant or impermeable), eye protection (goggles or face shield), and a mask.
- Additional protective equipment might be required in certain situations (e.g., copious amounts of blood, other body fluids, vomit, or feces present in the environment), including but not limited to double gloving, disposable shoe covers, and leg coverings.
- **Restrict visitors:** Avoid entry of visitors into the patient’s room.
- **Avoid aerosol-generating procedures:** Avoid aerosol-generating procedures. If performing these procedures, FPE should include respiratory protection (N95 or higher filtering facepiece respirator) and the procedure should be performed in an airborne infection isolation room.
- **Implement environmental infection control measures:** Diligent environmental cleaning and disinfection and safe handling of potentially contaminated materials is of paramount importance. As blood, sweat, vomit, feces, urine and other body secretions and potentially infectious materials should be done following hospital protocols.
 Diagnostic studies

• Within a few days after symptoms begin:
  – Antigen-capture enzyme-linked immunosorbent assay (ELISA) testing
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• Later in disease course or after recovery:
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  – Not yet on humans.

 ZMAPP

• A combination of monoclonal antibodies
• Reversion of advanced Ebola virus disease in nonhuman primates with Zmapp
  – Rescue of 100% of rhesus macaques when treatment is initiated up to 5 days post-challenge.
  – High fever, viremia and abnormalities in blood count and blood chemistry were evident in many animals before ZMapp intervention.
  – Advanced disease, as indicated by elevated liver enzymes, mucosal hemorrhages and generalized petechia could be reversed, leading to full recovery.
Prevention

• No licensed specific treatment or vaccine is available for use in people or animals.

• Barrier nursing techniques
  – Wearing of protective clothing (such as masks, gloves, gowns, and goggles)
  – Use of infection-control measures (such as complete equipment sterilization and routine use of disinfectant)
  – Isolation of Ebola patients from contact with unprotected persons.

References

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- CDC. Quarantine Station Contact List, Map, and Fact Sheets
  http://www.cdc.gov/quarantine/quarantinestationcontactlistfull.html

- CDC. U.S. Quarantine Stations
  http://www.cdc.gov/quarantine/quarantine-stations-us.html