Overview

- **Background on the virus**
  - Description
  - Ecology

- **Transmission**

- **Characteristics of Disease**

- **Outbreaks**
  - Historical
  - Current West African Outbreak and Local transmission

- **Environmental Persistence**

- **Recommendations for handling human wastes**
Ebola

- Family Filoviridae: enveloped single stranded negative sense RNA viruses
- Genera: Cuevavirus, *Ebolavirus*, Marburgvirus
- Species: Bundibugyo ebolavirus, Reston ebolavirus, Sudan ebolavirus, Taï Forest ebolavirus, and *Zaire ebolavirus*
- Enveloped virus
Ebolavirus Ecology

- Natural Reservoir has not been identified
- In outbreaks index case thought to become infected through contact with an infected animal
  - Fruit bat
  - Primates (apes and monkeys)
- Then person-to-person transmission follows
Ebola Virus Transmission

- Virus present in high quantity in blood, body fluids, and excreta of *symptomatic* EVD-infected patients*

- Opportunities for human-to-human transmission
  - **Direct contact** (through broken skin or unprotected mucous membranes) with an EVD-infected patient’s blood or body fluids
  - **Sharps injury** (with EVD-contaminated needle or other sharp)
  - Direct contact with the corpse of a person who died of EVD
  - Indirect contact with an EVD-infected patient’s blood or body fluids via a contaminated object (soiled linens or used utensils)

- Ebola can also be transmitted via contact with blood, fluids, or meat of an infected animal
  - Limited evidence that dogs become infected with Ebola virus
  - No reports of dogs or cats becoming sick with or transmitting Ebola

*Data on urine and feces based on PCR positivity only*
Infected persons are not contagious until onset of symptoms
Infectiousness of body fluids (e.g., viral load) increases as patient becomes more ill
- Remains from deceased infected persons are highly infectious
Human-to-human transmission of Ebola virus via inhalation (aerosols) has not been demonstrated
Transmission of Ebola

Transmission

- Direct contact with blood and body fluids from an infected person (alive/dead)
- Portal of entry mucous membranes, through open cut, wound, or abrasion, touching ones eyes, or splash to nose or mouth
How is Ebola not Transmitted

- Airborne: outbreaks have been contained without the use of airborne precautions
- Routine environmental exposures
- From pets (dogs, cats, etc.)
Clinical Manifestations

- **Incubation period:** 2-21 days; typically 8-10 days after exposure
- **Begin with abrupt onset of fever, usually accompanied with myalgia and headache**
- **Symptoms:**
  - Fever
  - Severe headache
  - Muscle pain
  - Weakness
  - Fatigue
  - Diarrhea
  - Vomiting
  - Abdominal pain
  - Unexplained hemorrhage (bleeding or bruising)
- **Mortality:** can be as high as 90% (Africa); <20% (Patients treated in US Hospitals)
Early Clinical Presentation

- Acute onset; typically 8–10 days after exposure (range 2–21 days)
- Signs and symptoms
  - Initial: Fever, chills, myalgias, malaise, anorexia
  - After 5 days: GI symptoms, such as nausea, vomiting, watery diarrhea, abdominal pain
  - Other: Headache, conjunctivitis, hiccups, rash, chest pain, shortness of breath, confusion, seizures
  - Hemorrhagic symptoms in 18% of cases
- Other possible infectious causes of symptoms
  - Malaria, typhoid fever, meningococcemia, Lassa fever and other bacterial infections (e.g., pneumonia) – all very common in Africa
Current Ebola Outbreak in Countries with Widespread Transmission

- 23,729 total cases
- 9,604 total deaths

As of February 25, 2015

Guinea, Sierra Leone, Liberia


<table>
<thead>
<tr>
<th>Country</th>
<th>Number of outbreaks</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple</td>
<td>1</td>
<td>2014</td>
</tr>
<tr>
<td>South Sudan</td>
<td>3</td>
<td>1976, 1997, 2004</td>
</tr>
<tr>
<td>South Africa</td>
<td>1</td>
<td>1996</td>
</tr>
<tr>
<td>Côte d'Ivoire</td>
<td>1</td>
<td>1994</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Cases (Suspected, Probable, Confirmed)</th>
<th>Lab Confirmed Cases</th>
<th>Total Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nigeria</td>
<td>20</td>
<td>19</td>
<td>8</td>
</tr>
<tr>
<td>Senegal</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Spain</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>United States</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Mali</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
<td><strong>32</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

*No active cases*
Two patients who had travelled to the endemic area have been diagnosed with Ebola virus disease following their return to the U.S.

Two nurses who cared for one of the patients were diagnosed with Ebola virus disease.
Cases Diagnosed in the United States

- September 30, 2014: man who traveled from Liberia to Dallas, Tx; admitted to Dallas, Tx Hospital (died on 10/08)
- October 10, 2014: Healthcare worker caring for index patient (recovered)
- October 15, 2014: 2nd Healthcare worker caring for index patient (recovered)
- October 23, 2014: Physician who worked with Doctors without Borders, NYC (recovered)
Transmission to Healthcare Personnel

- The risk is high
- Late stage illness with high viral loads and severe gastrointestinal symptoms increase the risk
- Limited experience with some invasive procedures (blood draws) can increase
- No data on risks during aerosol generating procedures
Timeline of events for Ebola patients 1, 2, 3, Dallas, TX

Ebola Virus Levels in Serum

![Graph showing log RNA copies/ml serum over days post onset of symptoms.](image)
Household Transmission Data

- 1995 outbreak in Kikwit, Democratic Republic of the Congo
- 28 of 173 household contacts of 27 primary patients developed Ebola
- All 28 reported direct physical contact with a known patient
  - Other studies with similar findings
- Several studies show people who shared confined space with a patient with Ebola, but did not have direct contact, did not develop Ebola

http://www.cdc.gov/vhf/ebola/transmission/human-transmission.html
Is This Outbreak Consistent with Others?

- Clinical course of infection similar to past outbreaks
  - Incubation period
  - Duration of illness
  - Case fatality rate
- Reproductive number ($R_0$) similar to past outbreaks (1.38-1.81)
General Characteristics Enveloped Viruses

- Envelopes typically arise from host cell membranes; lipid bilayers
- Presence of envelope is essential for entry of the cell
- Relatively sensitive to desiccation, heat, and detergents, pH (acid pH 2.4; alkaline pH >8)
- Have limited survival outside of the host
Previous Laboratory Studies on the Persistence of Ebola Virus in/on Environmental Matrices

- Persists on glass and plastic surfaces for at least 14 days @ 4°C;
- Persists in liquid media (tissue culture media, guinea pig plasma) for at least 50 days (Temp 4°C, in the dark)
- Viral inactivation rate ($1 \log_{10}$): 15.9 hr for EBOV; 4 $\log_{10}$ virus inactivated with in 5.9 days when dried onto Stainless steel, glass, rubber; Temp 20-25°C in the dark.

Preliminary Lab Data

- EBOV 2014 spiked into simulated gastric juice immediately inactivated
- EBOV 2014 spiked into simulated gastric juice with milk (simulating light meal) not immediately inactivated but virus could not be recovered 24 hr later
- EBOV 2014 spiked into irradiated pooled stool*; immediate 3 log\(_{10}\) reduction infectious virus could not be recovered 24 hr later (ambient temperature, smooth non-porous surfaces)

*pooled stool purchased from 25 healthy donors; stool matrices was itself inhibitory
DHS (unpublished data, 2015 studies are ongoing at NBBAC)
Persistence of Ebola virus in Fluids (A) and Tissues (B) from Cynomolgus Macaques

Virus culture and RT-PCR results from 54 clinical samples collected from 26 patients with laboratory-confirmed Ebola hemorrhagic fever.

<table>
<thead>
<tr>
<th>Sample type, phase of illness</th>
<th>Patients, no.</th>
<th>Samples, no.</th>
<th>Day after disease onset that sample was collected, range (mean)</th>
<th>Virus culture positive, no. (% sample type tested)</th>
<th>RT-PCR positive, no./total tested (%)</th>
<th>Latest day positive after disease onset</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Saliva</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>10</td>
<td>12</td>
<td>4–14 (6)</td>
<td>1 (8)</td>
<td>8/12 (67)</td>
<td>8</td>
</tr>
<tr>
<td>Convalescent</td>
<td>4</td>
<td>4</td>
<td>12–23 (16)</td>
<td>0 (0)</td>
<td>0/4 (0)</td>
<td>…</td>
</tr>
<tr>
<td><strong>Skin</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>7</td>
<td>8</td>
<td>4–10 (7)</td>
<td>0 (0)</td>
<td>1/8 (13)</td>
<td>6</td>
</tr>
<tr>
<td>Convalescent</td>
<td>3</td>
<td>3</td>
<td>7–15 (12)</td>
<td>0 (0)</td>
<td>0/3 (0)</td>
<td>…</td>
</tr>
<tr>
<td><strong>Urine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>5</td>
<td>7</td>
<td>5–22 (14)</td>
<td>0 (0)</td>
<td>0/7 (0)</td>
<td>…</td>
</tr>
<tr>
<td>Convalescent</td>
<td>4</td>
<td>4</td>
<td>8–40 (28)</td>
<td>0 (0)</td>
<td>0/4</td>
<td>…</td>
</tr>
<tr>
<td><strong>Vomit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>1</td>
<td>1</td>
<td>NA (9)</td>
<td>0 (0)</td>
<td>0/1 (0)</td>
<td>…</td>
</tr>
<tr>
<td>Convalescent</td>
<td>1</td>
<td>1</td>
<td>NA (20)</td>
<td>0 (0)</td>
<td>0/1 (0)</td>
<td>…</td>
</tr>
<tr>
<td><strong>Sputum</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>1</td>
<td>1</td>
<td>NA (8)</td>
<td>0 (0)</td>
<td>0/1 (0)</td>
<td>…</td>
</tr>
<tr>
<td>Convalescent</td>
<td>1</td>
<td>1</td>
<td>NA (16)</td>
<td>0 (0)</td>
<td>0/1 (0)</td>
<td>…</td>
</tr>
<tr>
<td><strong>Breast milk</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>1</td>
<td>1</td>
<td>NA (7)</td>
<td>1 (100)</td>
<td>1/1 (100)</td>
<td>7</td>
</tr>
<tr>
<td>Convalescent</td>
<td>1</td>
<td>1</td>
<td>NA (15)</td>
<td>1 (100)</td>
<td>1/1 (100)</td>
<td>15</td>
</tr>
<tr>
<td><strong>Stool</strong>&lt;sup&gt;b&lt;/sup&gt;, acute</td>
<td>4</td>
<td>4</td>
<td>4–12 (8)</td>
<td>0 (0)</td>
<td>2/4 (50)</td>
<td>12</td>
</tr>
<tr>
<td><strong>Sweat</strong>&lt;sup&gt;c&lt;/sup&gt;, acute</td>
<td>1</td>
<td>1</td>
<td>NA (9)</td>
<td>0 (0)</td>
<td>0/1 (0)</td>
<td>…</td>
</tr>
<tr>
<td><strong>Tears</strong>&lt;sup&gt;b&lt;/sup&gt;, acute</td>
<td>1</td>
<td>1</td>
<td>NA (6)</td>
<td>0 (0)</td>
<td>1/1 (100)</td>
<td>6</td>
</tr>
<tr>
<td><strong>Nasal blood</strong>&lt;sup&gt;c&lt;/sup&gt;, acute</td>
<td>1</td>
<td>1</td>
<td>NA (10)</td>
<td>0 (0)</td>
<td>1/1 (100)</td>
<td>10</td>
</tr>
<tr>
<td><strong>Body louse</strong>&lt;sup&gt;b&lt;/sup&gt;, acute</td>
<td>1</td>
<td>1</td>
<td>NA (9)</td>
<td>0 (0)</td>
<td>0/1 (0)</td>
<td>…</td>
</tr>
<tr>
<td><strong>Semen</strong>&lt;sup&gt;c&lt;/sup&gt;, convalescent</td>
<td>1</td>
<td>2</td>
<td>40–45 (43)</td>
<td>1 (59)</td>
<td>2 (50)</td>
<td>40</td>
</tr>
<tr>
<td><strong>Subtotal acute</strong></td>
<td>23</td>
<td>38</td>
<td>4–22 (9)</td>
<td>2 (5)</td>
<td>14 (37)</td>
<td>12</td>
</tr>
<tr>
<td><strong>Subtotal convalescent</strong></td>
<td>8</td>
<td>16</td>
<td>7–45 (21)</td>
<td>2 (13)</td>
<td>2 (13)</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>26&lt;sup&gt;d&lt;/sup&gt;</td>
<td>54</td>
<td>4–45 (12)</td>
<td>4 (7)</td>
<td>16 (30)</td>
<td>…</td>
</tr>
</tbody>
</table>

**NOTE.** Samples are classified as either acute phase (serum ELISA antigen positive and/or RT-PCR positive) or convalescent phase (previously serum ELISA antigen positive or RT-PCR positive but now reverted to negative, often with the appearance of ELISA IgG antibody). Clinical samples were classified as acute or convalescent phase on the basis of the results of the most closely matched serum sample by date, which was a mean difference of 1.2 days (range, 0–13 days) and 7.3 days (range, 0–29 days) for acute- and convalescent-phase samples, respectively. NA, not applicable.

<sup>a</sup> Samples were swabbed from the hand (10) or forehead (1). The sole positive sample was from a hand.

<sup>b</sup> No convalescent-phase samples were available for this sample type.

<sup>c</sup> No acute-phase sample was available for this sample type.

<sup>d</sup> Both acute- and convalescent-phase samples were collected from some patients.

Bausch D G et al. J Infect Dis. 2007;196:S142-S147
Virus culture and RT-PCR results from 33 environmental samples.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Color</th>
<th>Virus culture result</th>
<th>RT-PCR result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside of ward</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changing room wall</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Changing room desk</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Exterior surface of door of isolation ward</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Inside ward, suspected side</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurse’s newly placed glove</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Bed frame</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Instrument tray for ward rounds</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Inside ward, probable side</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air (tube opened and capped, negative control 1)</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Sterile swab (negative control 2)</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Intravenous fluid support pole</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Light switch</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Floor</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Handle of 0.05% bleach solution dispenser</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Nurse’s clean apron</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Nurse’s clean glove</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Clean stethoscope</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Stethoscope after use</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Stethoscope after use and rinsing with 0.05% bleach solution</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Bed frame</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Bedside chair (2 different samples)</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Food bowl</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Spit bowl</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Skin (hand) of patient attendants (3 different samples)</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Clean glove of patient attendant</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Corpse decontaminated with 0.5% bleach solution</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Body bag decontaminated with 0.5% bleach solution (2 different samples)</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Clean mattress</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Intravenous tubing</td>
<td>Clear</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Doctor’s blood-stained glove (positive control 1)</td>
<td>Pink</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Bloody intravenous insertion site (positive control 2)</td>
<td>Red</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Total (of all samples)</td>
<td>…</td>
<td>0 (0)</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Bausch D G et al. J Infect Dis. 2007;196:S142-S147

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LESSONS LEARNED FROM THE GLOBAL AIDS EPIDEMIC

Lab based studies and field investigations
déjà vu

- Similar experience to other enveloped virus of concern almost 30 years ago
- Human Immunodeficiency virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS)
- In the early 1980’s to early to mid ‘90s no available therapy; universally fatal
Persistence Studies with HIV

- HIV inoculated into sterile drinking water, sewage, and ocean water found up to 11 days after inoculation; virus infectivity was not assessed
- HIV Stable for 12 hr in wastewater at 25°C, with 2-3 log_{10} reduction within 24 hr (spiking concentration above the highest titers seen clinically) or what would be typically in wastewater


Enveloped Viruses In Sewage, or Wastewater Effluents

- Analysis of sewer effluent using an infectivity assay did not detect HIV
- Detect HIV in wastewater from Belle Glade (2 samples) an 1 sample from Pontiac, MI by PCR


Detection and Recovery of Enveloped Viruses from Sewage or Waste Water

- Coronaviruses including SARs CoV have been detected in sanitary plumbing systems by RT-PCR, however infectious virus has never been recovered from sewage samples
- HIV has been detected by RT-PCR, but no studies provided evidence for the presence of infectious virus using culture based methods
- Influenza virus has been detected using q-RT-PCR
- Herpes virus was found to persist in liquid manure but infectious titers rapidly decline
Most Current Research uses Metagenomic Approaches

Raw sewage harbors diverse viral populations. MBio 2011 Oct 4;2(5). pii: e00180-11
(http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3187576/)

Microbial Resistance to Physical and Chemical Methods for Inactivation

**Resistant**

- Prions (eg., CJD, nvCJD)
- Bacterial Endospores (eg., Bacillus, Clostridium)
  - Coccidia (eg., Cryptosporidia)
  - Mycobacteria
  - Nonlipid or small viruses (eg., polio, Norovirus)
  - Vegetative bacteria

**Susceptible**

- Lipid or medium sized viruses (eg. Ebola, HCV, HIV, HBV)

Factors that Impact Ebola Infectivity

- 3% Acetic acid, pH 2.5 (15 minutes)\textsuperscript{1}
- 60°C; 5 log\textsubscript{10} Inactivation in 22 minutes (hold for an hour for an extra margin of safety) \textsuperscript{1}
- Boiling, 5 min
- Sunlight
- Germicidal ultraviolet irradiation\textsuperscript{2}
- Detergents, Nanoemulsion\textsuperscript{3}
- \(\beta\)-propionolactone\textsuperscript{4}

\textsuperscript{2} Sagripanti JL, Lytle CD. \textit{Arch Virol} 2011;156:489-494
\textsuperscript{3} Chupernova AA, et al. \textit{Acta Tropica} 2003;87:315-320
\textsuperscript{4} Van der Groen G, Elliott LH. \textit{Ann Soc Belg Méd Trop} 1982; 62:49-54
Does Disinfection Work

- No direct data with Ebola virus
- CDC and EPA/Office of Pesticides/Antimicrobics Division using the hierarchy of resistance to disinfectants have a general agreement to use products the label claims against a non-enveloped virus (eg, adenovirus, poliovirus, rotavirus, norovirus, etc.)
- EPA List L Disinfectants for Use Against the Ebola Virus: [http://www.epa.gov/oppad001/list-l-ebola-virus.html](http://www.epa.gov/oppad001/list-l-ebola-virus.html)
  - Hospital grade disinfectants (eg., alcohol, halogens, quaternary ammonium compounds, peracetic acid, peroxides, phenolics)
  - List L is not all inclusive
- Processes in place to address enteric viruses would inactivate *Ebolavirus* and other members of the Filoviridae
Recommendations From WHO, 2014

- Waste, such as feces, urine and vomit, and liquid waste from washing, can be disposed of in the sanitary sewer or pit latrine.
- No further treatment is necessary

WHO. Interim Infection Prevention and Control Guidance for Care of Patients with Suspected or Confirmed Filovirus Haemorrhagic Fever in Health-Care Settings, with Focus on Ebola, 2014
(http://www.who.int/csr/resources/publications/ebola/filovirus_infection_control/en/)
5 Is it safe for Ebola patients to use the bathroom?

Yes. Sanitary sewers may be used for the safe disposal of patient waste (WHO, 2014). Additionally, sewage handling processes in the United States are designed to inactivate infectious agents.

Consistent with other recommendations by CDC with using sanitary sewers for Disposal of other potentially infectious body fluids

Interim Guidance for Managers and Workers Handling Untreated Sewage from Individuals with Ebola in the United States

November 20, 2014

Who this is for: Workers who handle untreated sewage that comes from hospitals, medical facilities, and other facilities with confirmed individuals with Ebola.

What this is for: To provide recommendations for workers on the types of personal protective equipment (PPE) to be used and proper hygiene for the safe handling of untreated sewage that may contain Ebola virus.

How to use: Use this document to reduce the workers’ risk of exposure to infectious agents including Ebola virus when working with untreated sewage.

Key Points:

- Ebola virus is more fragile than many enteric viruses that cause diarrheal disease or hepatitis.
- The envelope that covers Ebola makes it more susceptible to environmental stresses and to chemical germicides than non-enveloped viruses, such as hepatitis A, poliovirus, and norovirus.
- To protect workers against Ebola
  - Educate them on
How do We Protect Sewage Workers

- Use Appropriate PPE to protect against contact with human wastes
  - Goggles or face shield: to protect eyes from splashes of untreated sewage
  - Face mask (e.g., surgical mask): to protect nose and mouth from splashes of human waste. If undertaking cleaning processes that generate aerosols, a NIOSH-approved N95 respirator should be used.
  - Impermeable or fluid-resistant coveralls: to keep untreated sewage off clothing
  - Waterproof gloves (such as rubber) to prevent exposure of hands to untreated sewage
  - Rubber boots: to prevent exposure of feet to untreated sewage
OSHA PPE Selection Matrix for Occupational Exposure to Ebola Virus

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Basic Hygiene Practices

- Wash skin with soap and water immediately after handling sewage, or any materials that have been in contact with sewage.
- Avoid touching face, mouth, eyes, nose, or open sores and cuts while handling sewage, or any materials that have been in contact with sewage.
- Wash your hands with soap and water before eating or drinking after you have handled sewage.
- Remove soiled work clothes and do not take home to launder. Launder clothing at work or use a uniform service.
- Eat in designated areas away from untreated sewage.
- Do not smoke or chew tobacco or gum while handling human waste or sewage, or any materials that have been in contact with sewage.
- Cover open sores, cuts, and wounds with clean, dry bandages.
Why are There no Formal Recommendations For Treating Waste

- Ebola is an enveloped virus
- ≤ 10% of patients are excreting virus in their feces (WHO)
- Some preliminary data suggests infectious virus does not persist long
- No increased exposure to HBV, HCV, HIV, Influenza through sewage
- Unlike enteric viruses (non-enveloped) recovery of infectious enveloped viruses from sewage, wastewater, sludge or biosolids has not been very successful
Treatment of Patient Wastes Prior to Discharge

- Some utilities are requiring pre-treatment
  - One hospital has used bleach
  - One has used a quaternary ammonium compound

- Disinfection of waste
  - No data on efficacy
  - Bleach may be a patient safety risk because of chemical fumes

- Some utilities required no discharge: Use of camping toilet with solidifier
  - Disposal with other solid Ebola-Associated waste

For questions regarding environmental infection control, disinfection, waste Management: eocevent181@cdc.gov
http://www.cdc.gov/vhf/ebola/index.html