SURVIVAL OF EBOLA IN SEWAGE AND DURING WASTEWATER TREATMENT: EVALUATION USING A VIRAL SURROGATE

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BACKGROUND

- Ebola is a member of the *Filoviridae* family
- First member of *Filoviridae* encountered was The Marburg virus in 1967 (appeared in Marbury Germany)
- Ebola virus encountered in late 1970s in Democratic Republic of the Congo (DRC)
- Ebola “disappeared” for 15 years, then reappeared in 1994-1996
  - Côte d’Ivoire (1994)
  - DRC (1995)
- Outbreaks led to the best seller “The Hot Zone” by Richard Preston
EBOLA

- Filovirus
- Causes Ebola Hemorrhagic Fever (EHF)
- Causes disease in humans and primates (monkeys and chimpanzees)
- High mortality rate ≈ 50%
- Preliminary estimate ID$_{50}$ of three viruses
- The current epidemic in Africa largest outbreak ever
2014 OUTBREAK

WEST AFRICA
# 2014 Outbreak

<table>
<thead>
<tr>
<th>Country</th>
<th>Cases</th>
<th>Deaths</th>
<th>Last update</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liberia</td>
<td>7,690</td>
<td>3,161</td>
<td>2 December 2014</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>7,676</td>
<td>2,014</td>
<td>4 December 2014</td>
</tr>
<tr>
<td>Guinea</td>
<td>2,192</td>
<td>1,366</td>
<td>3 December 2014</td>
</tr>
<tr>
<td>Nigeria</td>
<td>20</td>
<td>8</td>
<td>outbreak ended 20 October 2014</td>
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<tr>
<td>Mali</td>
<td>8</td>
<td>6</td>
<td>23 November 2014</td>
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<tr>
<td>United States</td>
<td>4</td>
<td>1</td>
<td>16 November 2014</td>
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<tr>
<td>Senegal</td>
<td>1</td>
<td>0</td>
<td>outbreak ended 17 October 2014</td>
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<td>Spain</td>
<td>1</td>
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<td>outbreak ended 2 December 2014</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17,590</strong></td>
<td><strong>6,556</strong></td>
<td><strong>as of 3 December 2014</strong></td>
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FATE OF EBOLA IN THE ENVIRONMENT

• Virtually no information
• Can survive for 30 to 40 days (time for 99.9% decrease in infectivity) in serum and culture at 4°C
• Concern over exposure via contaminated sewage
• Need to determine fate of Ebola during wastewater/biosolids treatment
OBJECTIVE
Utilize a viral surrogates for Ebola to evaluate its survival in sewage and during wastewater treatment.

APPROACH
• Survival in medical waste that could be flushed down the toilet with and without disinfection
• Survival during mesophilic and thermophylic anaerobic digestion of sewage sludge – tests done in miniature anaerobic digesters. Also, lime treatment to produce Class A biosolids from Class B
SURVIVAL DURING WASTEWATER TREATMENT

- Miniature Anaerobic Digestors
  - Test tubes

- Add 1° sludge + activated sludge inoculant
- Validated in previous study with prions by monitoring VOCs
- Add virus and allow to digest anaerobically at mesophilic and thermophilic temperatures
VIRUS ASSAYS

• Cell culture – to determine loss of infectivity
• qPCR – to determine breakdown of nucleic acid
POTENTIAL SURROGATES FOR EBOLA AND OTHER EMERGING VIRUSES

• Parainfluenza
  • -in the same order as Ebola virus
  • Related to other emerging viruses (Hendra and Nipagh viruses)
• Corona virus
  • In the same order as Ebola virus
  • SARS is a coronavirus
• Murine norovirus (tough virus) – worst case for virus survival
RATIONALE FOR SURROGATE

- Biosafety – level 4 required for Ebola
- Surrogates selected based on similarity to Ebola
  - In the same viral order
  - nucleic acid type
  - contain lipids
  - replication
  - Easy to grow in cell culture
  - Require only a biosafety level 2
  - Related to other emerging viruses
KEY DELIVERABLES

• Key information on potential routes of exposure via sewage and sewage treatment
• Progress reports
• Peer-review publications
BUDGET REQUESTED

- Personnel $18,000
- Operations $10,000

PERIOD OF PERFORMANCE