Preventing Waterborne Disease

Professor Kristen Jellison
BioS 010
November 7, 2011
Waterborne Disease – Global Statistics

- 1.1 billion people lack access to improved water supply
- 2.6 billion people lack access to improved sanitation
- Between 1.085 to 2.187 million deaths each year due to diarrheal diseases can be attributed to the ‘water, sanitation, and hygiene’ risk factor
  - 90% of these deaths are among children under age 5
Burden of Waterborne Disease

- Water-related disease is the 2nd biggest killer of children worldwide (1st = acute respiratory infections)

- At any one time:
  - half of the world’s hospital beds are occupied by patients suffering from water-related diseases (WaterAid, 2008)
  - half of the population of the developing world is suffering from one or more diseases associated with inadequate water and sanitation (WaterAid, 2008)
Burden of Waterborne Disease

- 443 million school days lost annually to water-related diseases

  - to reduce by half the proportion of people without access to safe water and sanitation by 2015
  - An extra $10 billion needed each year to reach the goal (this is about half of what rich countries spend on mineral water)
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**Ultimate goal**: Prevention of waterborne disease

- **Water treatment technologies** (emphasis on developing countries)
  - Ceramic filtration
  - Biosand filtration

- **Watershed management**
  - Parasite fate and transport
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Ultimate goal: Prevention of waterborne disease

Water treatment technologies (emphasis on developing countries)
- Ceramic filtration
- Biosand filtration

Watershed management
- Parasite fate and transport
Ceramic Filtration

- Potters for Peace filter
  - 2 separate parts: (i) ceramic pot and (ii) plastic container that the pot sits inside
  - Ceramic pot has colloidal silver coating (germicide)
  - Ceramic has very small pores which entrap contaminants as water passes through
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**Ultimate goal**: Prevention of waterborne disease

Water treatment technologies  
(emphasis on developing countries)
- Ceramic filtration  
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Watershed management
- Parasite fate and transport
Biosand Filtration

- 0.3m x 0.3m x 0.9m
- Weight: 170 lbs.
- Costs: $10-45 USD
Biosand Filtration

2 L Pitcher Filter
Biosand Filtration

From spiked water tank

2 concrete BSFs
2 concrete BSFs modified with rusty nails
2 bucket (5-gal) BSFs
2 bucket (5-gal) BSFs modified with rusty nails
2 bucket (2-gal) BSFs
2 bucket (2-gal) BSFs modified with rusty nails
Biosand Filtration
Biosand Filtration

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>Std Dev</th>
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<tbody>
<tr>
<td>Influent</td>
<td>4.82</td>
<td>61.37</td>
<td>30.17</td>
<td>18.40</td>
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<tr>
<td>Concrete</td>
<td>0.15</td>
<td>1.61</td>
<td>0.43</td>
<td>0.29</td>
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<tr>
<td>5gal buckets</td>
<td>0.15</td>
<td>1.60</td>
<td>0.46</td>
<td>0.31</td>
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<tr>
<td>2gal buckets</td>
<td>0.23</td>
<td>1.41</td>
<td>0.53</td>
<td>0.28</td>
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Biosand Filtration

Bacteria Removal for 6-hour Pause Period

<table>
<thead>
<tr>
<th></th>
<th>Week 1</th>
<th>Week 7</th>
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<tbody>
<tr>
<td><strong>Log_{10} Bacteria Reduction</strong></td>
<td></td>
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<tr>
<td>E. coli</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Coliforms</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Concrete</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Concrete nails</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>5-gal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>5-gal nails</strong></td>
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<tr>
<td><strong>2-gal</strong></td>
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<tr>
<td><strong>2-gal nails</strong></td>
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</tr>
</tbody>
</table>
Biosand Filtration

Virus Removal for 6-hour Pause Period

Log$_{10}$ MS2 Reduction

Week 2 & 3

- Concrete
- Concrete nails
- 5-gal bucket
- 5-gal bucket nails
- 2-gal bucket
- 2-gal nails

Week 5 & 6

- Concrete
- Concrete nails
- 5-gal bucket
- 5-gal bucket nails
- 2-gal bucket
- 2-gal nails
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**Ultimate goal**: Prevention of waterborne disease

- Water treatment technologies (emphasis on developing countries)
  - Ceramic filtration
  - Biosand filtration

- Watershed management
  - Parasite fate and transport
Cryptosporidium
Cryptosporidium Life Cycle

- Ingested
- Exits Host
- Type I Meront
- Type II Meront
- Thick-walled Oocysts
- Thin-walled Oocysts
- Host Enterocytes
- Sporozoite
- Merozoites
- Microgamont
- Macrogamont
- Zygote
- Auto-infection

(Adapted from Current & Blagburn, 1990)
Cryptosporidiosis

(Adapted from Current & Blagburn, 1990)
Solar UV Radiation
Cryptosporidium and Biofilms

Attachment 1

Growth 2

Detachment 3

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P. Dirckx
Solar Exposure
Summary

Ultimate goal: reduce prevalence of waterborne disease

- Optimize household water treatment options in developing countries and develop standard operating procedures for their use
- Understand parasite fate and transport in the environment
- Identify public health risk associated with parasites in drinking water supplies
- Improve methods for watershed monitoring of parasites
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Questions?
Contact Information

Prof. Kristen Jellison
Office: STEPS Room 344
Phone: x8-3555
Email: krj3@lehigh.edu