Water and Infectious Disease - Waterborne Disease

- Global distribution of infectious disease
- Transmission cycles
- Water and infectious disease
- Enteric disease in children
- Case studies
  - *E.coli*
  - Cholera (*Vibrio cholerae*)
  - *Cryptosporidium parvum*
Infections related to water may be classified into four main groups.

**Water-borne** diseases, where the pathogen is transmitted by ingestion of contaminated water. Cholera and typhoid are often spread this way.

**Water-washed** diseases involve fecal-oral or other spread from one person to another facilitated by the lack of adequate supplies of water for washing. Many diarrheal diseases as well as infections of the skin and eyes are transmitted this way.

**Water-based** infections are those caused by pathogenic organisms which spend part of their life cycle in aquatic organisms. The schistosomes and other trematode parasites which parasitize snails, and guinea worm (dracunculiasis), which is spread through minute aquatic crustaceans, are examples.

**Water-related insect vectors** include those which breed in water, such as the mosquitoes which spread malaria, filariasis, dengue and yellow fever; and black flies which transmit river blindness (onchocerciasis). Also, some of the tsetse flies that transmit sleeping sickness bite preferentially near water.
What is needed to control waterborne disease?

- Reduce exposure to excrement
- Sanitation - proper disposal of feces
- Water - quantity
- Water - quality
**Microbial Pathogenicity**

- Entry into host
- Find a unique niche
- Evasion, subversion or circumvention of initial host defense mechanisms
- Multiplication or persistence
- Cause overt disease (optional)
- Exit the host - transmissibility

“A key distinction is that a pathogen has an inherent capacity to breach host cell barriers, whereas a commensal species and opportunistic pathogens do not.”


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**Escherichia coli**

- *commensal*
- *part of normal gut microflora*

Enterohemorrhagic *E. coli* - pathogen, causes GI disease
Enterotoxigenic *E. coli* - *
Enteropathogenic *E. coli* - *
Enteroaggregative *E. coli* - *
Enteroinvasive *E. coli* - *
Virulence of *Vibrio cholerae* [Classical Inaba strain]

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<tbody>
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<td>2</td>
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<tr>
<td>Symptoms</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>None</td>
<td>4 (30%)</td>
<td>10 (19%)</td>
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</tr>
<tr>
<td>Mild diarrhea</td>
<td>9 (70%)</td>
<td>28 (54%)</td>
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<tr>
<td>Severe diarrhea</td>
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<td>14 (27%)</td>
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The intersection of *V. cholerae* ecology and cholera

- phytoplankton
- zooplankton
- transmission of cholera to humans via ingestion of fecal *V. cholerae* in water and food
- classic fecal-oral transmission from human to human via ingestion of fecal *V. cholerae* in water and food

Physical & chemical characteristics of water:
- temperature
- sunlight
- rainfall
- pH
- dissolved oxygen tension
- salinity & other chemical nutrients

Transmission of *F. cholerae* to humans via ingested water containing colonized copepods or other vectors

Map 3: Countries or areas reporting cholera, 1998
Domestically acquired cholera cases in the United States 1992-1994

2 exposure: eating shellfish harvested off Gulf Coast caused by endemic Gulf Coast *Vibrio cholerae* 01

4 exposure: unusual foods of non-US origin

No evidence of secondary transmission in the US

From: Mahon et al. 1996, JAMA, 276: 307-312
Features favoring transmissibility of Cryptosporidium parvum

- Broad host ranges
- Life cycle in single host / autoinfective
- Highly infectious
- Oocysts fully infective upon excretion
- Large numbers of oocysts may be shed
- Ubiquitous distribution in environment
- Highly resistant to disinfection and environmental pressures
- No effective therapy
Conclusions

- the distribution of cases is consistent with common source exposure
- tapwater may contribute to endemic cryptosporidiosis
Eighty-eight percent of the members of Congress who tried to weaken water standards in 1994 had bottled water delivered to their Capitol Hill offices.