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Waterborne Disease

Water is essential for life, yet it can also harbor life-threatening pathogens, toxins, or chemicals. Access to clean drinking water and safely treated recreational water is often taken for granted in developed countries. However, a number of waterborne disease agents continue to pose a risk in the United States, including Washington. Review of these risks is important as Washington heads into its summer recreational water season.

Waterborne Disease Agents

Water is essential for life. Many people in this country take for granted that there are safe and readily available sources of water for drinking, cooking, and recreation. However, water can be the source for a number of infectious and non-infectious agents. Some of the waterborne disease agents – particularly enteric pathogens – can also transmitted through other routes, such as food, animal contact, or directly from person-to-person. For instance, an epidemiologist investigating an outbreak of Shiga toxin-producing *E. coli* among summer camp attendees may need to consider whether the common source was a swimming pond (waterborne), menu item (foodborne), or a petting zoo visit (zoonotic).

Testing water at a village spring, Haiti
www.cdc.gov

Waterborne pathogens may be found in various water types, e.g.,

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drinking, recreational, ornamental, or industrial. The route of entry into the human body can also vary, as can effects on the body's organ systems. If there is an exposure, the agent, water type, route of entry, and clinical manifestations are all important. These factors are summarized in the Table.

Table. Various catagorizations and examples of waterborne illness agents

CATEGORY	EXAMPLES
Agent	
Virus	Norovirus, hepatitis A virus, poliovirus
Bacterium	*Shigella*, *Campylobacter*, Shiga toxin-producing *E. coli*, *Legionella*, *Pseudomonas*, *Vibrio cholera*, non-cholera *Vibrio*
Parasite	*Cryptosporidium*, *Giardia*, *Naegleria fowleri*, *Schistosoma* flatworm
Non-infectious agent	Harmful algal bloom (HAB) toxins (e.g., microcystin, domoic acid)
Water Type	
Drinking Water	Municipal water supply, private well
Recreational Water – Treated	Swimming pool, hot tub, waterpark
Recreational Water – Untreated	Ocean, river, stream, lake
Other	Grocery store mister, ornamental fountain, cooling tower
Route of Entry	
Ingestion	Enteric pathogens (e.g., norovirus, *Shigella*, *Giardia*), HAB toxins
Inhalation	*Legionella*, HAB toxins
Intranasal	*Naegleria fowleri*
Skin contact	*Schistosoma*, *Vibrio* (wounds), HAB toxins
Clinical Manifestation	
Gastrointestinal	Enteric diseases (e.g., shigellosis, giardiasis), HAB toxins that affect stomach/intestines
Respiratory	Legionellosis, HAB toxins
Neurologic	Primary amoebic meningoencephalitis (from *Naegleria fowleri*), HAB neurotoxins
Dermatologic	*Pseudomonas*, swimmer's itch, HAB toxins
Other or systemic	HAB hepatotoxins (liver)

While water is a common vehicle for waterborne disease agents, the reservoirs for these infectious pathogens may vary. For instance, water itself – or soil or other environmental sources – is the primary reservoir for certain agents, including *Legionella* species, non-cholera *Vibrio*, non-tuberculosis *Mycobacterium* species, *Schistosoma* flatworms, and free-living amoeba. In contrast, animals, often via fecal contamination, are the primary reservoirs for a number of bacterial or parasitic waterborne disease agents, including *Campylobacter jejuni*, *Cryptosporidium*, Shiga

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toxin-producing *E. coli*, *Francesella tularensis*, *Giardia*, *Leptospira*, schistosomes, and non-typhoid *Salmonella* species.

Humans, via fecal contamination of drinking water supplies, can also serve as reservoirs for many of the waterborne disease agents carried by animals. In addition, humans are the sole reservoir for some agents, such as hepatitis A virus, *Shigella*, *Salmonella* Typhi (typhoid fever), *Vibrio cholerae* (cholera), norovirus, and other viruses such as rotavirus and poliovirus.

Epidemiology of Waterborne Disease Outbreaks in Washington

From 1996 through 2015, 24 waterborne disease outbreaks were reported to the Washington State Department of Health (DOH) Office of Communicable Disease Epidemiology (OCDE), with a median of 1 (range, 0 to 3) outbreaks per year and a median of 11 cases (range, 3-260) per outbreak. Due to under-recognition and underreporting, the true burden of waterborne outbreaks is likely many times higher.

During 1996-2015, the most common etiology for waterborne disease outbreaks was norovirus or unknown viral cause of gastroenteritis (N = 6); other causes included *Pseudomonas* (4), *Legionella* (3), *Cryptosporidium* (2), *E. coli* (2), harmful algal bloom (2), *Campylobacter* (1), *Shigella* (1), and unidentified agents (3). Additional causes of reported waterborne disease outbreaks in Washington prior to 1996 included *Giardia*, hepatitis A virus, *Mycobacterium*, *Salmonella*, and *Staphylococcus*.

The three largest waterborne disease outbreaks in the two-decade period of 1996-2015 were gastrointestinal and included a norovirus outbreak associated with lake swimming in 2014 (approximately 260 cases), a campylobacteriosis outbreak associated with cross-contaminated drinking water lines in 2003 (110 cases), and suspected viral illness associated with a swimming lake in 1998 (248 cases).

Of the 24 reported waterborne disease outbreaks during 1996-2015, 15 (63%) were due to exposure to recreational water (6 from treated water and 9 from untreated water), 7 (29%) were due to drinking water, and 2 (8%) were due to unknown water sources. The median number of cases in drinking water outbreaks was 32 (range, 3-110), nearly three times higher than the median number of 11 (range, 3-260) cases in recreational water outbreaks.

Disease Reporting and Public Health Investigation

Individual cases of many waterborne illnesses are notifiable to public health authorities (http://www.doh.wa.gov/ForPublicHealthandHealthcareProviders/NotifiableConditions/ListofNotifiableConditions).

Outbreaks of waterborne disease are also notifiable. For surveillance purposes, a waterborne disease outbreak is defined as an incident in which two or more epidemiologically-linked

persons experience a similar illness after exposure to the same water source, which is implicated by epidemiologic evidence as the likely source of the illness.

The epidemiologic investigation for a waterborne disease outbreak ideally includes working closely with environmental health staff to identify causes and control measures.

Possible Climate Change Impacts on Waterborne Disease Risk

Climate models for Washington State project a warmer climate by the mid-21st century. Along with rising air temperatures and longer duration of warm seasons, water temperatures could also increase. Droughts could occur, as well as extreme weather events such as floods. These various conditions could increase environmental prevalence of certain waterborne disease agents and subsequent risk for human disease. This will require strong disease surveillance and environmental health systems to prevent, monitor, detect, and respond to disease outbreaks.

Resources

Department of Health Waterborne Disease Outbreak Guideline:
http://www.doh.wa.gov/Portals/1/Documents/5100/420-044-Guideline-WaterOutbreak.pdf

CDC toolkits:

- Drinking water: http://www.cdc.gov/healthywater/emergency/preparedness-resources/drinking-water-outbreak-toolkit.html
- Recreational water: http://www.cdc.gov/healthywater/emergency/preparedness-resources/rec-water-outbreak-toolkit.html
- Legionellosis: http://www.cdc.gov/legionella/health-depts/inv-tools-cluster/index.html