A microscopic view of water, showing various organisms and pathogens. The background is a dark, textured blue-green. In the upper left, there is a large, elongated, green, hair-like structure. In the upper right, there is a smaller, similar structure. In the lower left, there is a large, green, oval-shaped organism with long, thin, hair-like appendages. The overall scene is illuminated with a blue-green light, giving it a glowing appearance.

Emerging and Re-emerging Pathogens: Compelling Reasons to Protect Drinking Water

By Kathy Jesperson • On Tap Editor

According to Centers for Disease Control and Prevention (CDC) surveillance data, between 1999 and 2000, 25 states reported a total of 39 outbreaks associated with drinking water. Included among them was one *Salmonella* outbreak that spanned 10 states. Altogether, the waterborne illnesses affected an estimated 2,068 people and were linked to two deaths.

At one time, it seemed that science had defeated waterborne disease. But now that doesn't appear to be the case. Emerging and re-emerging pathogens have become a great concern for public health officials and drinking water systems around the country.

Giardiasis • *Giardia intestinalis* • The Cycle

Emerging pathogens are either new to the environment or only recently identified as potential health threats. Re-emerging pathogens are pathogens that we know about but haven't encountered in a while.

They cause diseases such as cholera and shigellosis.

According to the World Health Organization (WHO), new pathogens show up for many reasons. One of the biggest reasons that they appear is that microorganisms are constantly evolving, adapting, and changing their structure.

Another reason is that we've gotten better at detecting the microbes that cause waterborne disease because we have developed new tools and methods to study the organisms and their health effects.

Pathogens Have Greatest Health Impact

Pathogens present the greatest waterborne threat to the public's health because it only takes a small number of microbes to cause illness—especially for people who may have unique health risks, such as those with compromised immune systems, says the U.S. Environmental Protection Agency (EPA).

In addition, emerging pathogens, such as *Cryptosporidium*, *Giardia lamblia*, and Hepatitis E, share the following characteristics:

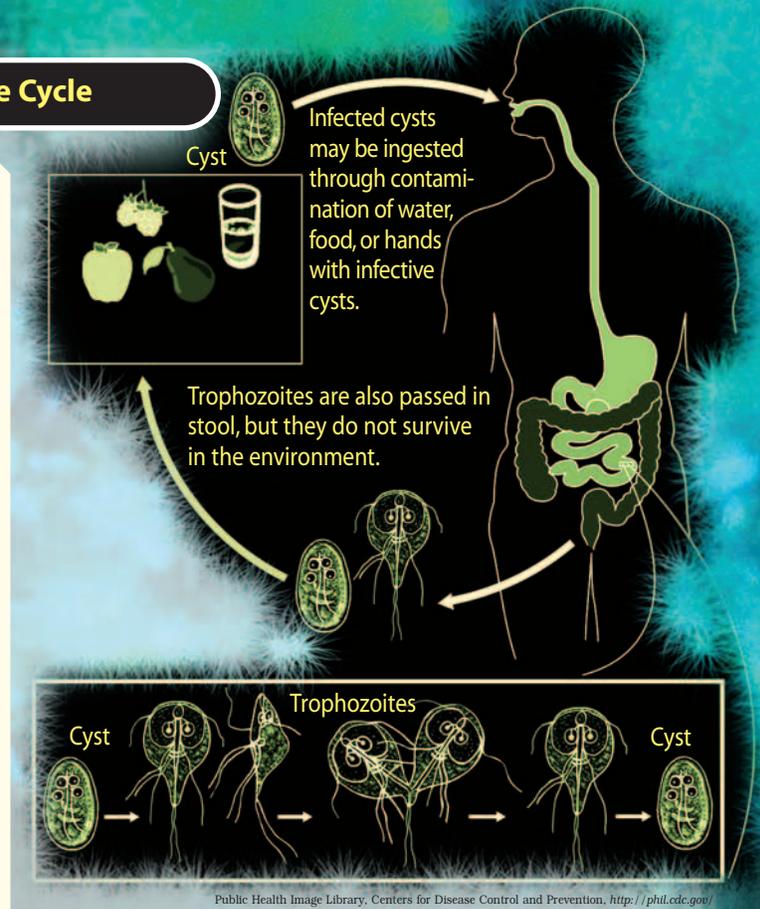
- They are often resistant to chlorination or other forms of disinfection.
- The pathogens are often resistant to antibiotics or other medical treatment.
- They are often highly infectious.

EPA notes that emerging and re-emerging pathogens include pathogens from fecal sources, such as *Cryptosporidium*, *Campylobacter*, and rotavirus, as well as pathogens that are able to grow in water distribution systems, such as *Legionella*, mycobacteria, and aeromonads.

The following list of emerging pathogens was developed from information from the CDC, EPA, the U.S. Geological Survey, the National Institutes of Health, and WHO.

Bacteria

Aeromonas is a bacterium that normally lives in an aquatic environment. *Aeromonas* represent a high percentage of heterotrophic microorganisms in a variety of aquatic sys-

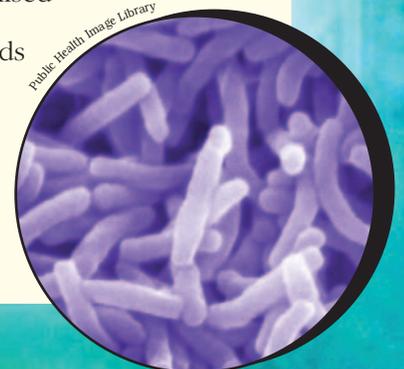


Public Health Image Library, Centers for Disease Control and Prevention, <http://phil.cdc.gov/>

tems. Heterotrophic microorganisms are bacteria and other microorganisms that use the organic matter that other organisms synthesize for energy and growth. For this reason, their potential public health threat cannot be ignored. *Aeromonas* have been found in sewage and sewage effluents, surface water, fish ponds, soils, natural mineral springs, stagnant water, chlorinated and unchlorinated drinking water, and fresh waters. They act as primary pathogens and significantly sicken the fish that they invade.

Campylobacter is a bacterium from the genus *Campylobacter*. Most people who become ill with campylobacteriosis get diarrhea, cramping, abdominal pain, and fever within two to five days after exposure to the organism. The diarrhea may be bloody and can be accompanied by nausea and vomiting. The illness typically lasts one week. Some people who are infected with *Campylobacter* don't have any symptoms at all. In those with compromised immune systems, *Campylobacter* occasionally spreads to the bloodstream and causes a serious life-threatening infection.

Cholera is the illness caused by a bacterium called *Vibria cholerae*.



It infects people's intestines, causing diarrhea, vomiting and leg cramps. It seems like every time there are floods, earthquakes or any disasters in developing countries of the world, an outbreak of cholera follows quickly. Infection is acquired primarily by ingesting contaminated water or food; person-to-person transmission is rare. Since 1961, *V. cholerae* has spread from Indonesia through most of Asia into Eastern Europe and Africa, and from North Africa, to the Iberian Peninsula. In 1991, an extensive epidemic began in Peru and spread to neighboring countries in the Western Hemisphere. In 2001, nearly 185,000 cases from 58 countries were reported to WHO.

Cyanobacteria (blue-green algae) are found in ponds, lakes, and reservoirs. They are aquatic and photosynthetic, meaning they live in the water and can manufacture their own food. Cyanobacteria are unicellular bacteria that often grow in colonies large enough to see with the naked eye. They can produce toxins—usually neurotoxins or hepatoxins. There is good evidence that certain hepatoxins promote liver tumors. Currently, most worldwide reports of cyanobacterial toxin poisonings have involved livestock, dogs, and waterfowl. Well-documented cases of effects on humans are relatively few, but there are some reports of dermatitis, eye irritation, and gastrointestinal symptoms.

***E. coli* O157:H7** is a bacterium that has been associated primarily with undercooked beef and raw milk. But waterborne outbreaks have been reported, including one in Missouri that sickened 243 people and left four dead, and one in Wyoming that sickened at least 50 people.

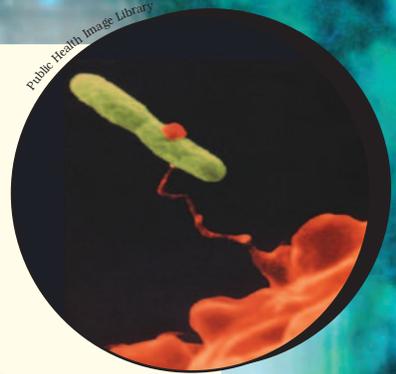
Helicobacter pylori is a bacterium linked to gastric ulcers. Penn State University (PSU) researchers report that they have found a direct link between the presence of a bacterium in Pennsylvania drinking water and stomach ulcers. The research team tied *Helicobacter pylori* in well water and clinical infection in people drinking from that supply. PSU researchers made the association between water containing *H. pylori* and the infection through tests of private wells supplying drinking water to individual households. Interviews with residents who consumed the water found a significant correlation between presence of the bacterium and cases of stomach ulcers.

Legionella pneumophila is a bacterium that was discovered in 1976 at an American Legion convention in Philadelphia.

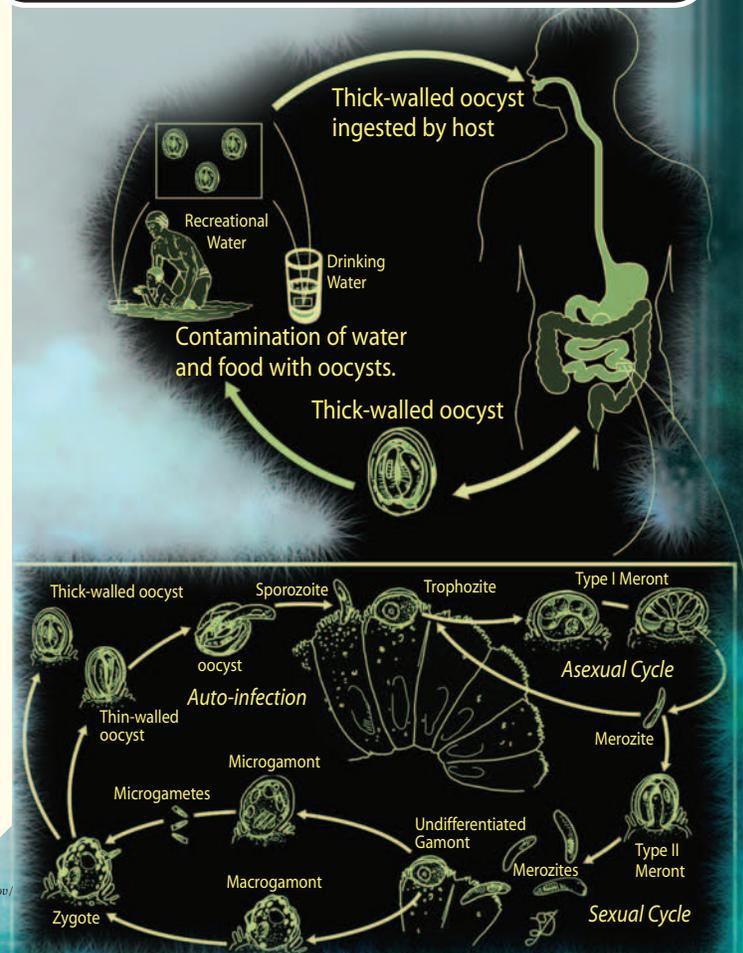
Investigators originally believed that an abandoned cooling tower was its source, but recent research indicates that the *Legionella* might have been introduced through a potable water system. While *Legionella* are relatively resistant to standard water disinfection procedures, research has produced effective ways to control and prevent it in potable water systems, including hyperchlorination, ultraviolet light, and ozonation.

Mycobacterium has been linked to tuberculosis. *M. avium* and *M. intracellulare* complex, long considered a group of organisms that rarely infects humans, is now recognized as one of the leading opportunists associated with AIDS. *M. leprae* causes leprosy, which remains a major disease in the third world. *M. bovis* causes tuberculosis.

Salmonella is a bacterium that causes salmonellosis. Most people infected with *Salmonella* develop diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. The illness usually lasts four to seven



Cryptosporidiosis • *Cryptosporidium* • The Cycle



days, and most people recover without treatment. However, in some people diarrhea may be so severe that the patient needs to be hospitalized. In these patients, the *Salmonella* infection may spread from the intestines to the blood stream and then to other body sites and can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness.

Shigellosis is an infectious disease caused by a group of bacteria called *Shigella*.

Most who are infected with *Shigella* develop diarrhea, fever, and stomach cramps starting a day or two after they are exposed to the bacterium. The diarrhea is often bloody. Shigellosis usually lasts five to seven days. In some people, especially young children and the elderly, the diarrhea can be so severe that the patient needs to be hospitalized. A severe infection with high fever may also be associated with seizures in children less than two years old. Some people who are infected may have no symptoms at all but may still pass the *Shigella* bacteria to others.

Protozoa

Cryptosporidiosis is a diarrheal disease caused by *Cryptosporidium parvum*—a protozoan that can live in the intestine of humans and animals and can be passed in the stool. Both the disease and the parasite are also known as crypto. An outer shell protects the parasite and allows it to survive outside the body for long periods of time. The shell also makes it very resistant to chlorine disinfection. During the past two decades, crypto has become recognized as one of the most common causes of waterborne disease in humans in the U.S. The parasite is found in every region of the U.S. and throughout the world.

Giardia lamblia is a protozoan that is most frequently the cause of non-bacterial diarrhea in the U.S. Human giardiasis may involve diarrhea within one week of ingestion of the cyst. Cysts are resistant to adverse environmental conditions and are passed in the feces of an infected host, and the next host is infected when it ingests cysts in food or water contaminated with feces. Normally, illness lasts for one to two

weeks but there are cases of chronic infections lasting months to years. Chronic cases, both those with defined immune deficiencies and those without, are difficult to treat.

Viruses

Hepatitis E generally affects young adults and usually is not life threatening. The exception is in pregnant women, who have had fatality rates of 15 to 20 percent. According to CDC, virtually all cases of hepatitis E have occurred among travelers returning from developing countries where the disease is endemic and spreads through contaminated drinking water. Nevertheless, tests show that between one and five percent of healthy blood donors in the U.S. have hepatitis E antibodies in their blood.

Rotavirus infects the digestive tract. It is the most common cause of severe diarrhea in infants and young children in the U.S. *Rotavirus* is easily spread by hand-to-mouth contact with stool from an infected person. Most children with *rotavirus* diarrhea recover without medical treatment. Some children, however, become very ill with severe vomiting, diarrhea, and life-threatening loss of fluids.

If you need to report a waterborne disease outbreak, call CDC's Division of Parasitic Diseases, NCID, at (770) 488-7760 or by fax at (770) 488-7761.

For more information, contact: EPA's Safe Drinking Water Hotline at 800-426-4791, visit their Web site www.epa.gov/safewater, or e-mail them at hotline-sdwa@epa.gov; or contact CDC's National Center for Infectious Diseases at www.cdc.gov/ncidod. Call the CDC at (888) 232-3228, or send a fax to (888) 232-3299. ♻️

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