Giardia also threatens drinking water supplies

The intestinal protozoan *Giardia* is a leading cause of waterborne illness in humans. Like *Cryptosporidium*, *Giardia* has a simple life cycle, alternating between an active form that colonizes the intestines of the host and causes diarrhea, and resistant cysts that are passed from the body in the feces. The cysts can survive for long periods in the environment and cause infection when ingested by another host. Unlike *Cryptosporidium*, there are effective drugs for treating *Giardia* infection.

More than 100 outbreaks of waterborne giardiasis have occurred in the United States since 1965. Most of these outbreaks have been attributed to contamination of surface water with human sewage. *Giardia* is also commonly spread by direct person-to-person, fecal-oral transfer of cysts, and giardiasis outbreaks have been associated with poor hygiene or inadequate sanitary conditions in day-care centers, nurseries and public institutions. Foodborne transmission from infected workers or family members can also occur.

Although *Giardia* infection is common in a wide variety of wildlife and livestock species, there is considerable controversy over the issue of whether cysts shed by animals can infect humans. Investigators have been unable to determine conclusively the host origin of *Giardia* cysts detected in the majority of waterborne outbreaks.

The evidence for zoonotic transmission of giardiasis from animals to humans is circumstantial. *Giardia* isolates from humans have been experimentally transmitted to other animals, including beavers and muskrats. In the wild, the reported prevalences of *Giardia* infection in these aquatic mammals are 7 to 16% for beavers and over 95% for muskrats, but the *Giardia* species isolated from these animals appear to be different from those that infect humans.

Sheep, goats, pigs, horses and cattle have also been implicated as potential sources for transmission of giardiasis to humans. We have found up to 27% of California range beef cattle to be shedding *Giardia* in their feces, with the majority of infections occurring in calves. We also detected shedding of *Giardia* in 4 to 6% of California horses. Despite the isolation of *Giardia* from these hosts, there exists considerable controversy among researchers as to whether *Giardia* from livestock is infectious to humans under natural conditions.

Taxonomic confusion is a major impediment to resolving the question of zoonotic transmission. Some investigators have named *Giardia* species based on their host origin, while others have based species designations on morphological features of the protozoans. Currently, researchers are using various molecular analyses to distinguish different species. It remains unclear, however, how many species of *Giardia* infect humans or what species are involved in waterborne outbreaks.

Just as *Cryptosporidium* oocysts are ubiquitous in surface water throughout North America, *Giardia* cysts are also found in a majority of surface water samples. As with *Cryptosporidium* oocysts, however, available tests cannot determine whether the detected cysts are infectious to humans. From a practical standpoint, given the scientific uncertainties, any *Giardia* cysts found in water must be considered potentially infectious to humans. *Giardia* cysts can be removed by filtration and are not as resistant to chlorine-based disinfectants as *Cryptosporidium* oocysts.

–Tim Stephens

It is not known how people typically become infected with *Cryptosporidium*. Drinking water was clearly the primary transmission vehicle in Milwaukee and in other major outbreaks of cryptosporidiosis. In general, however, the relative importance of various possible transmission routes is unclear. Food-related outbreaks have involved raw milk, possibly raw sausage, tripe, kefir and apple juice. During the Milwaukee outbreak, *Cryptosporidium* carried in tap water was suspected of contaminating salad dressings, dairy products and sausages, so the suspect foods were recalled.

Illness in humans

No drug is known to be effective in treating the infections and illnesses caused by these pathogens. *E. coli* O157:H7 and several other, less common strains of *E. coli* produce a toxin similar to Shiga toxin of *Shigella dysenteriae* and cause severe bloody diarrhea in humans. The infection can lead to kidney failure (hemolytic uremic syndrome) and death.

Shiga toxin–producing *E. coli* are notably more resistant to acid conditions (as in apple juice) than nonpathogenic strains of *E. coli*. *E. coli* O157:H7 can survive a pH as low as 2.0 under certain circumstances (Armstrong et al. 1996). The bacteria can multiply in foods and elsewhere in the environment under some conditions, as well as in the host's body. They can be killed by heat, chlorine or UV light. An internal temperature of 155°F during cooking is sufficient to kill more than 99% of organisms in ground beef (Bell et al. 1994).

The largest documented outbreak of foodborne illness caused by *E. coli* O157:H7 occurred in Japan in 1996, when more than 9,000 people became ill and at least 11 died. The source of the outbreak was never determined.

Cryptosporidium infection causes watery diarrhea associated with abdominal cramping, nausea, vomiting and fever. In people with normal resistance, cryptosporidiosis is a self-limiting illness from which most patients recover after a few days or weeks. Those with compromised immune systems, however, develop