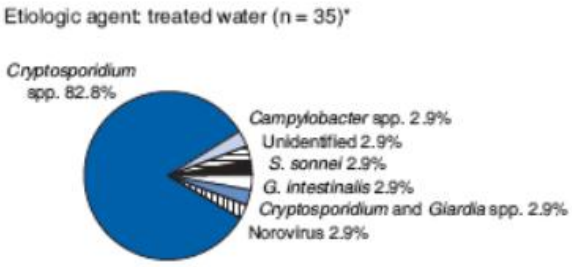
Why *Cryptosporidium* is Responsible for over 80% of Swimming Pool Illness Outbreaks, and What Can be Done about It

By the Water Quality & Health Council

Cryptosporidium is a microscopic parasite that is responsible for the majority of swimming pool illness outbreaks in the US with symptoms ranging from diarrhea to death. An outbreak this summer in Ohio sickened hundreds of swimmers. With that level of notoriety, it should come as no surprise that "*Crypto*" was the subject of much discussion at the recent National Swimming Pool Foundation's annual World Aquatic Health Conference in Nashville (October 19-21). The figure at right illustrates the dominant role of "*Crypto*" in 35 reported recreational water illness outbreaks between 2005 and 2006.



Causes of recreational water illness outbreaks, 2005-2006 (CDC MMWR Report, Sept. 12 2008)

Crypto lives in the intestines of mammals and is what is known as an enteric pathogen, spread through the feces of infected people and animals. According to the Centers for Disease Control and Prevention (CDC), *Crypto* can cause diarrheal disease in people two to ten days after they become infected. Swimming pool *Crypto* outbreaks start when fecal matter from an infected swimmer or animal contaminates pool water. Given that a single fecal event can release over one billion organisms into the water and ingesting as few as 10 or fewer organisms can cause infection in a healthy person,[1] the disease potential of *Crypto* is both extremely high and easily observed once an outbreak begins. Symptoms usually last from one to two weeks, but may last longer in people with weakened immune systems. Infectious oocysts can be excreted for up to 60 days after gastrointestinal symptoms have ended. Death can result when the immunocompromised (e.g., young children, the elderly and the chronically ill) are infected.

Chlorine Resistance

Unlike the other waterborne pathogens represented in the pie chart above, *Crypto* is chlorine-resistant. This unique characteristic explains why it is the most common cause of illness in pool swimmers. Most waterborne pathogens are destroyed by chlorine, and many pools are adequately chlorinated to achieve that level of protection. In its infectious form, however, *Crypto* sports a thick, protective, outer shell known as an "oocyst."

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[1] Yoder, J.S, Wallace, R.M., Collier, S.A., Beach, M.J. and Hlavsa, M.C., "Cryptosporidiosis Surveillance-United States, 2009-2010," *Morbidity and Mortality Weekly Report*, September 7, 2012. On line, available: http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6105a1.htm

Filtering Crypto

In this year's World Aquatic Health Conference's "Advanced Filtration Science" symposium, University of North Carolina at Charlotte researcher and professor Dr. James Amburgey provided helpful perspective around the *Crypto* issue by noting that analytical testing for *Crypto* is expensive, and that often the pool management is unaware of its *Crypto* problem until there is an outbreak. His experiments show *Crypto* oocysts escape swim diapers within *five minutes* of a diapered child being in the pool. Additionally, research shows 8.3% of noninstitutionalized adults are fecally incontinent.[2] Just one fecal "event" in a pool can release over one billion oocysts into the water!

Optimizing Filtration

Because chlorine disinfection is ineffective against *Crypto* at normal swimming pool levels, oocysts must be removed through filtration (or exposed to advanced disinfection units employing ozone or UV light). Dr. Amburgey stated that a typical swimming pool sand filter removes only about 25 percent of oocysts each time the water is filtered (typically every 4-6 hours). Fortunately, there are several chemical and design factors that can be tweaked to achieve much greater removal rates. For this, the researcher recommended all three of the following techniques already employed by the drinking water industry:

- Slowing the rate of filtration (≤ 10 gallons per minute per square foot of filter area)
- Increasing the filter depth (≥ 24 inches of 0.5 mm effective size sand)
- Using coagulants (0.1 mg aluminum per liter of water with alum or polyaluminum chloride)

The first two factors make intuitive sense: Slowing the rate of pool water filtration and increasing the filter depth increase the odds of oocysts being caught in the matrix of a pool filter. Most importantly, however, Dr. Amburgey emphasized that coagulants dramatically enhance filtration. As filter media and oocysts are both negatively charged, there are no electrical attractions between them to enhance filtration. Positively charged coagulants added to swimming pool water, however, can effectively promote oocysts sticking to filter media. It is important to note that optimizing coagulation for *Crypto* removal can be complicated and is best left to researchers.

Other options suggested to enhance filtration include replacing sand with at least 18" of Ceraflow-70 (an ultrafine granular ceramic media), ceramic membrane filters, and the use of "precoat filters" where a woven material is precoated with at least 0.15 pound of diatomaceous earth (a fine powder) per square foot of filter area (forming a layer that is roughly 1/8" thick) that has pores small enough to trap *Crypto* particles. With pore sizes in the range of 1 micron (0.001 millimeter), diatomaceous earth can remove 99.99% of oocysts of diameter 4 microns in pool water.

Time will tell if swimming pool filtration is more widely optimized to help prevent future US *Crypto* outbreaks. As the recent World Aquatic Health Conference demonstrates, one thing is for sure: The right discussions are taking place.

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[2] Whitehead, W.E., Borrud, L., Goode, P.S., Meikle, S., Mueller, E.R., Tuteja, A., Weidner, A., Weinstein, M., Ye, W., (2009). "Fecal incontinence in US adults: epidemiology and risk factors," *Gastroenterology*, 137(2): 512-7.