

# INFECTIOUS DISEASES IN CHILDREN®

Volume 17, Number 5

THE PEDIATRICIAN'S NO. 1 NEWS SOURCE

May 2004

## Prevention of recreational water illnesses

### ► Is chlorination enough to ensure healthy swimming?

by Mei Lin Castor, MD, MPH, and Michael Beach, PhD

Special to *INFECTIOUS DISEASES IN CHILDREN*

In June of 1998, the Georgia Division of Public Health investigated a cluster of diarrheal illnesses reported by a day care facility. The investigation identified 26 people infected with *Escherichia coli* O157:H7; seven of these people developed hemolytic uremic syndrome and one died. The source of exposure was traced to a water park that ill people had visited prior to the onset of illness. The investigation revealed inadequate levels of chlorine disinfectant in a suspect "kiddie" pool during the critical exposure time period. Poor maintenance of disinfectant levels at the water park was believed by investigators to have contributed to the transmission of disease.

In August of 2001, the Illinois Department of Public Health was notified of a cluster of diarrheal illnesses in people who had recently attended a water park. The investigation identified 358 case-patients infected with the parasite *Cryptosporidium*. A case-control study showed that case-patients were more likely than age-matched controls to have attended and swum at the water park, to have had pool water in their mouth and to have swallowed it. Samples of pool water were

found to contain *Cryptosporidium*. Maintenance records at the water park revealed adequate chlorine levels during the suspected period of transmission. There were routine checks for, and adjustment of, both chlorine and pH levels. Daily fecal accidents were reported as confirmed by a fecal accident log and staff recollection. Despite adequate facili-

**Health care providers may help to teach parents of ill children and patients about healthy swimming habits. These simple and practical messages (posted by the CDC at [www.healthyswimming.org](http://www.healthyswimming.org)) include the following:**

- Don't swim when you have diarrhea.
- Don't swallow pool water.
- Shower with soap and water before swimming.
- Wash your hands with soap and water after using a toilet or after changing diapers.
- Take your children on bathroom breaks or check diapers often.
- Change diapers in a bathroom and not at poolside.
- Wash your child thoroughly with soap and water before swimming.

Source: [www.healthyswimming.org](http://www.healthyswimming.org)

ty maintenance and compliance with standard treatment guidelines for disinfected venues, transmission of disease occurred. Critical to this occurrence was the chlorine-resistant nature of the *Cryptosporidium* parasite.

These two outbreak scenarios raise important issues regarding to chlorination and healthy swimming. Aren't all

disinfected swimming venues maintained well? Doesn't chlorination kill everything so that pool water is sterile? These outbreaks help to dispel these societal myths about swimming pools. Swimming pool water safety has traditionally focused on the issues of preventive measures for drowning, injuries and lightning strikes. However, as these examples demonstrate, swimming pools and other disinfected recreational venues may also serve as settings for infectious disease transmission. Water safety programs should also include knowledge and preventive measures for recreational water illnesses.

### Recreational water illnesses

Recreational water illnesses (RWI) refer to a spectrum of illnesses acquired from swallowing, breathing or coming into contact with contaminated water in recreational water venues. Recreational water venues include treated or disinfected venues such as swimming pools, water parks and hot tubs. They also include untreated or naturally occurring bodies of water, such as lakes, rivers and the ocean.

The spectrum of RWIs includes ear, eye, gastrointestinal, neurologic, respiratory and skin infections.

This article will focus on diarrheal illnesses, which account for most illness reported from recreational water venues. Waterborne diarrheal pathogens include viruses (noroviruses), bacteria (*E. coli*, *Shigella*) and parasites (*Cryptosporidium*, *Giardia*). People most susceptible to gastrointestinal RWIs are the young, the elderly, the pregnant and the immuno-

compromised. Illness in this last population may be the most severe and life-threatening, as seen with the significant morbidity associated with *Cryptosporidium* infections in the immunocompromised.

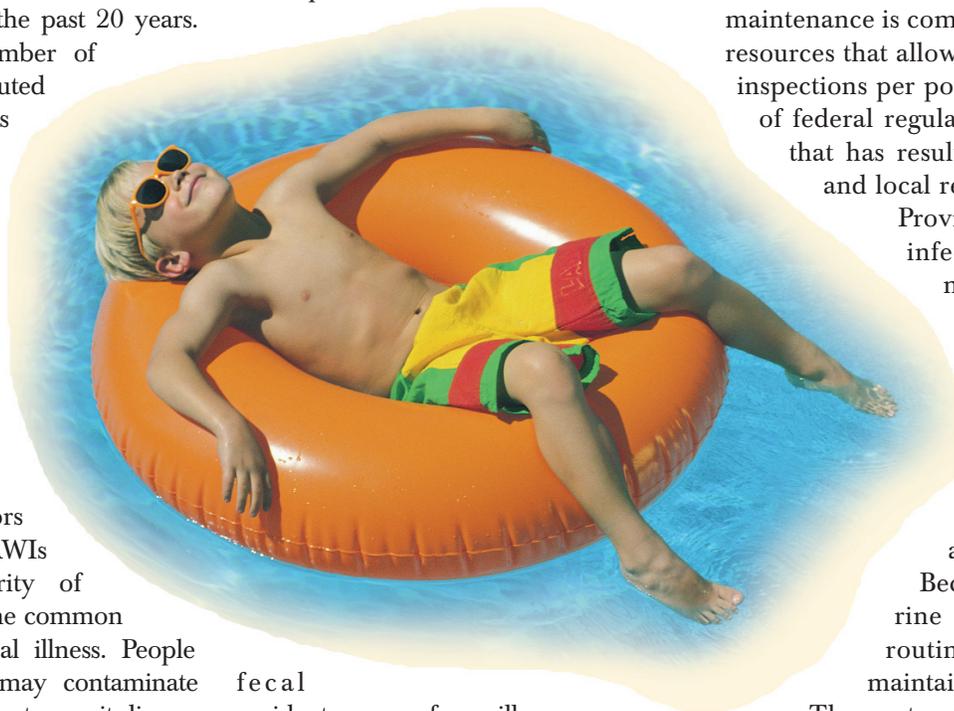
Ongoing surveillance by the CDC and state health departments has shown increasing trends of RWI outbreaks of diarrheal illness over the past 20 years. For instance, the number of RWI outbreaks attributed to *Cryptosporidium* has increased tenfold from 1990 to 2000; in the past two years, 80% of these diarrheal illness outbreaks in recreational water venues have been due to the chlorine-resistant nature of *Cryptosporidium*.

Contributing factors to the emergence of RWIs include the popularity of swimming as well as the common occurrence of diarrheal illness. People who swim when ill may contaminate venues, which may then transmit disease to healthy swimmers.

### Contamination of swimming venues

There may be several routes of contamination for swimming venues. Natural water venues may be contaminated by infected animals defecating in watershed areas or by point source contamination (eg, sewage outflows). For disinfected and natural water venues, contamination may also occur from patrons. A high bather

density that includes toddler and diapered children engaging in activities of communal bathing and water sharing increases the likelihood of water contamination. Fecal accidents, improper cleansing after bowel movement and feces from swimmers' bodies may all add up to several pounds of feces a day in the average water park. If



fecal accidents occur from ill swimmers with infectious diarrhea, the release of waterborne pathogens creates a health risk to other swimmers. Because waterborne pathogens such as *Cryptosporidium* and *Giardia* have such low infectious doses, consumption of only small volumes of water may be required for disease transmission to occur.

### Chlorination of disinfected venues

Advancements in technology over the last century have resulted in disinfection methods and environmental improvements that help to ensure the cleanliness of recreational water venues. Despite this, RWI outbreaks have emerged over the past two decades. Chlorination and other disinfectants are the first line of defense against disease transmission in disinfected recreational water venues. As the first outbreak demonstrates, inadequate facility maintenance may result in transmission of chlorine-sensitive pathogens.

The state of pool maintenance in

the United States is demonstrated by surveillance data from more than 22,000 swimming pool inspections performed during the summer of 2002. Fifty-four percent of inspections had one or more violations (range: one to 12 violations). Eight percent of inspections resulted in immediate pool closure. Assurance of adequate pool maintenance is complicated by limited resources that allow only a few annual inspections per pool as well as a lack of federal regulation and oversight that has resulted in varied state and local regulations.

Providing adequate disinfection for swimming venues has other challenges.

Urine, sunlight, aeration and organic matter all serve to deplete the levels of free available chlorine. Because of this, chlorine levels should be routinely measured to maintain adequate levels.

The potency of chlorine to inactivate pathogens is intimately tied to pH levels. As the pH goes up, the ability of chlorine to effectively disinfect decreases. Therefore, checking for and maintaining appropriate pH levels is critical to ensure effective disinfection.

### Chlorine-resistant waterborne pathogens

Even the best-maintained pools may transmit disease. The second outbreak discussed demonstrates how RWI transmission may occur despite adequate facility maintenance. Key to this are the characteristics of environmental stability and chlorine resistance found in several waterborne pathogens, such as *Cryptosporidium* and *Giardia*.

Chlorine typically kills most waterborne pathogens in less than an hour. *Cryptosporidium*, found throughout the United States and the world, provides the greatest challenge as a RWI pathogen. The presence of a highly resistant outer shell allows it to survive in the environment for long periods as

**The presence of a highly resistant outer shell allows *Cryptosporidium* to survive in the environment for long periods as well as to withstand rapid chlorine inactivation.**

well as to withstand rapid chlorine inactivation. Its small size also challenges conventional filtration systems. *Cryptosporidium* can survive for days in swimming pools. For example, the inactivation time for typical pool water (1 ppm [1 mg/L] chlorine, pH 7.5, 77° F) is less than one minute for *E. coli* vs. 9,600 minutes (6.7 days) for *Cryptosporidium*. The good news is that chlorine will eventually kill all waterborne pathogens. The bad news is that you do not always know which pathogens, if any, are present in the water after a fecal accident.

### Strategies for healthy swimming

RWI transmission occurs in inadequately chlorinated recreational water venues. It may also occur in adequately maintained venues when chlorine-resistant pathogens are involved. Because of the complex nature of RWI transmission, it is essential to incorporate a multidisciplinary approach in prevention and control strategies.

Human behavior plays a pivotal role in RWI transmission. Swimmers who are symptomatic with diarrhea may contaminate swimming venues; this poses health risks for healthy co-swimmers. Healthy swimming messages should be dissemi-

nated to general public, especially in patients with diarrhea, parents of diapered and toddler-aged children. In addition, high-risk groups such as the young, the elderly, the pregnant and the immunosuppressed should also be advised about healthy swimming habits.

Health care providers may help to teach parents of ill children and patients about healthy swimming habits. These simple and practical messages (posted by the CDC at [www.healthyswimming.org](http://www.healthyswimming.org)) include the following:

- Don't swim when you have diarrhea.
- Don't swallow pool water.
- Shower with soap and water before swimming, and be particularly meticulous about washing the crotch area.
- Wash your hands with soap and water after using a toilet or after changing diapers.
- Take your children on bathroom breaks or check diapers often.
- Change diapers in a bathroom and not at poolside.
- Wash your child thoroughly with soap and water before swimming.

It may be judicious to recommend that patients ill with infectious diarrhea refrain from swimming for the two weeks after cessation of diarrhea, particularly if

they are infected with *Cryptosporidium* or *Giardia*: these may be excreted for several weeks even after symptom resolution. These same prevention measures apply to people traveling domestically and/or internationally.

Recreational water venues provide opportunities for people to increase their level of physical activity and enjoy their leisure time. The message is to continue enjoying swimming, but only after adopting healthy swimming habits that will prevent disease transmission for oneself, one's family, fellow swimmers and others. **IDC**

---

### For more information:

Gilbert L, Blake P. Outbreak of *Escherichia coli* O157:H7 infections associated with a water park. *Georgia Epidemiol Rep.* 1998;14(7):1-6.

Lee SH, Levy DA, Craun GF, et al. Surveillance for waterborne-disease outbreaks – United States, 1999-2000. *MMWR Surveill Summ.* 2002;51(8):1-47. Can be accessed online at: [www.cdc.gov/mmwr/preview/mmwrhtml/ss5108a1.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5108a1.htm).

CDC. Surveillance data from swimming pool inspections - selected states and counties, United States, May-September 2002. *MMWR.* 2003;52(22):513-516. Can be accessed online at: [www.cdc.gov/mmwr/preview/mmwrhtml/mm522a1.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm522a1.htm).

The CDC has swimming safety information at [www.healthyswimming.org](http://www.healthyswimming.org).