MMWR Weekly
July 27, 2007 / 56(29);729-732

Cryptosporidiosis Outbreaks Associated with Recreational Water Use --- Five States, 2006

Cryptosporidiosis is a gastrointestinal illness caused by parasitic protozoa of the genus *Cryptosporidium* and can produce watery diarrhea lasting 1--3 weeks (*1*); one or two cases per 100,000 population are reported annually in the United States (*2*,*3*). Fecal-oral transmission of *Cryptosporidium* oocysts occurs through ingestion of contaminated drinking or recreational water, consumption of contaminated food, and contact with infected persons or animals (e.g., cattle or sheep). Unlike bacterial pathogens, *Cryptosporidium* oocysts are resistant to chlorine disinfection and can survive for days in treated recreational water venues (e.g., public and residential swimming pools and community and commercial water parks*) despite adherence to recommended residual chlorine levels (1--3 ppm) (*4*). For 2006, a total of 18 cryptosporidiosis outbreaks have been reported (as of July 24, 2007) to CDC's U.S. Waterborne Disease and Outbreak Surveillance System, compared with five outbreaks reported for 2003 and seven for 2004 (*5*); data for 2005 and 2006 are not yet final. This report describes five laboratory-confirmed cryptosporidiosis outbreaks in 2006 that involved public recreational water use (*2*). The popularity of recreational water venues, the number and geographic distribution of recent cryptosporidiosis outbreaks, and the resistance of *Cryptosporidium* to chlorination suggest that treatment strategies for recreational water facilities need to be improved.

Colorado. On August 23, 2006, a mother notified the Tri-County Health Department that some persons had experienced gastroenteritis after attending her daughter's birthday party at a Douglas County community water park. A cohort study was conducted among all 21 party attendees, who were surveyed using an Internet-based questionnaire. Twelve persons (57%) reported diarrhea, vomiting, or abdominal cramps. All seven of the stool samples collected contained *Cryptosporidium*, and all four of the samples tested further contained the same genotype of *Cryptosporidium hominis*. Twelve (71%) of the 17 persons with water exposure at the water park reported illness, compared with none of the nine persons who were not exposed to water (p=0.02, Fisher's exact test). A water sample collected from the water park 18 days after the party did not detect *Cryptosporidium*. The implicated water park pool and three other pools in the county where one of the ill persons swam were hyperchlorinated. Overall, during August--October 2006 in Douglas County, 11 cases of laboratory-confirmed cryptosporidiosis were reported (i.e., among seven of the 12 party attendees who reported illness, two of their household contacts, and two unrelated cases), compared with a median of one case (range: zero to three) reported annually during 2001--2005; no other outbreaks were reported or detected during this period.

Illinois. On August 10, 2006, a mother notified the Tazewell County Health Department that her two sons had received a diagnosis of cryptosporidiosis. The brothers had attended a private day-camp facility with a swimming pool and also participated in a day-camp outing to a community water park. A cohort study was conducted among day-camp attendees, staff members, and volunteers; 105 (64%) of 165 persons were interviewed by telephone. Fifty-six (53%) of those interviewed reported diarrhea or vomiting. Seven of eight stool samples collected contained *Cryptosporidium*; all four of the samples tested further contained the same genotype of *C. hominis*. Fifty-six (89%) of the 63 persons who entered the day-camp swimming pool reported illness, compared with none of the 39 persons who did not enter the pool (p<0.01, Mantel-Haenszel chi-square). Forty-one (85%) of the 48 persons with water exposure at the water park reported illness,

compared with 15 (28%) of the 54 persons who were not exposed to water (relative risk: 3.1; 95% confidence interval [CI] = 2.0--4.8). Testing of water samples determined that the day-camp pool was negative for *Cryptosporidium*, and the water park was positive for *Cryptosporidium parvum* but negative for *C. hominis*. The implicated day-camp pool was closed, and the water park was hyperchlorinated. During July--August 2006 in Tazewell County, seven cases of laboratory-confirmed cryptosporidiosis were reported, all from the day camp, compared with a median of four cases (range: one to 203) reported annually during 2001--2005; one large outbreak associated with a different community water park occurred in 2001.

Louisiana. During July--August 2006, a total of 35 cases of laboratory-confirmed cryptosporidiosis were reported to the Louisiana Office of Public Health from East Baton Rouge and Ascension parishes, compared with a median of one case (range: one to 42) reported annually during 2001--2005; one large outbreak associated with a water spray park occurred in 2005. *Cryptosporidium* isolates from the 35 patients were not subject to genotyping or species determination. A case-control study was conducted, and 29 (83%) of the 35 case-patients were interviewed by telephone. Twenty-nine controls were selected randomly from the Louisiana Immunization Registry database and matched to the case-patients by age and location. The 29 interviewed case-patients reported diarrhea (100%), abdominal cramps (62%), and vomiting (45%). Recreational water use at one commercial water park was the only exposure significantly associated with cryptosporidiosis (matched odds ratio [mOR]: 15.0; CI = 2.0--113.6). No water park samples were collected for testing because the water park had already closed for the season.

South Carolina. During 2006, a total of 123 cases of laboratory-confirmed cryptosporidiosis were reported to the South Carolina Department of Health and Environmental Control, compared with a median of 19 cases (range: seven to 29) reported annually during 2001--2005. In the Charleston region (i.e., Berkeley, Charleston, and Dorchester counties), 88 laboratory-confirmed cases were reported, compared with a median of seven cases (range: one to seven) reported annually during 2001--2005; no other outbreaks were reported or detected during this period. *Cryptosporidium* isolates for the 88 patients were not subject to genotyping or species determination. Eighty-one (95%) of 85 patients reported in the Charleston region during June--November 2006 were interviewed by telephone. Although no controls were interviewed, multiple water parks, swimming pools, and day care centers were identified as common sources of exposure. As a result, health department staff members visited eight of the identified recreational water venues and 13 of the identified day care centers to examine policies and implement control measures (e.g., hyperchlorinate recreational water). A water sample collected from one water park tested negative for *Cryptosporidium*.

Wyoming. During June--October 2006, 34 cases of laboratory-confirmed cryptosporidiosis were reported to the Wyoming Department of Health from Campbell and Crook counties, compared with a median of two cases (range: zero to three) reported annually during 2001--2005; no other outbreaks were reported or detected during this period. *Cryptosporidium* isolates from these 34 patients were not subject to genotyping or species determination. A case-control study was conducted with 29 patients; 26 (90%) of the 29 were interviewed by telephone. Forty-one unmatched controls were enrolled from among persons who were not ill and were seeking routine preventive care at a local public health nursing office. The 26 interviewed case-patients reported diarrhea (92%), vomiting (56%), and abdominal cramps (54%). Recreational water use at any public swimming pool (odds ratio [OR]: 6.8; CI = 1.4--33.6) and at one local reservoir (OR: 5.2; CI = 1.4--19.7) were the only exposures significantly associated with cryptosporidiosis. A water sample collected from one public pool tested negative for *Cryptosporidium*. The largest public swimming pool in the two-county region was hyperchlorinated.

Reported by: *NB Alden, MPH, TS Ghosh, MD, RL Vogt, MD, Tri-County Health Dept, Colorado. C Andreasen, MS, S Buller-Fenton, MS, Tazewell County Health Dept; L Saathoff-Huber, MPH, Illinois Dept of Public Health. J Davis, SA Henry, MPH, R Ratard, MD, Louisiana Office of Public Health. A Roach, MSPH, D Drociuk, J Meredith, PhD, R Ball, MD, South Carolina Dept of Health and Environmental Control. L Baker, MSPH, J Grandpre, PhD, T Murphy, MD, C Van Houten, MS, Wyoming Dept of Health. MJ Beach, PhD, H Bishop, AJ DaSilva, PhD, VR Hill, PhD, L Xiao, PhD, National Center for Zoonotic, Vector-Borne, and Enteric Diseases; TK Boehmer, PhD, JM Brunkard, PhD, KA Christian, DVM, R Luce, DVM, IC Trevino, DVM, EIS officers, CDC.*

Editorial Note:

This report describes five cryptosporidiosis outbreaks that occurred in the United States during 2006 and were associated with recreational water venues. Three of

the outbreaks (in Louisiana, South Carolina, and Wyoming) were not reported immediately but were detected through routine communicable disease surveillance of laboratory-confirmed cases. Such detection is typical for cryptosporidiosis, in part because of the long incubation period (1--12 days) and difficulty identifying clusters outside of organized group events. Four of the five outbreaks were epidemiologically associated with exposure to treated recreational water in swimming pools or water parks. These findings implicate contaminated recreational water as the source of the outbreaks, despite the negative results from environmental water samples. Detection of *Cryptosporidium* is uncommon in environmental water samples; laboratory testing is both technically and operationally challenging and, because of the long incubation period, often is not conducted until weeks after the exposure occurs. *Cryptosporidium* oocysts typically enter treated recreational water venues via fecal contamination from humans. Stool samples from two states (Colorado and Illinois) underwent species analysis by polymerase chain reaction and genotyping based on GP60 gene sequencing; samples from both states were identified as *C. hominis*, indicating a human source of contamination (*6*).

Because of its resistance to chlorination, *Cryptosporidium* has become the leading cause of gastroenteritis outbreaks associated with treated recreational water venues and accounted for approximately 60% of the outbreaks reported to CDC during 1995--2004 (*5*). Of the recreational water venues that were inspected for disinfection and chlorination, all but one (the Illinois day-camp pool) had records indicating adherence to recommended residual chlorine levels. These outbreaks underscore that conventional chlorination and filtration of swimming pools and water parks are inadequate to control cryptosporidiosis and transmission of recreational water illness (*4*).

Two types of public health intervention might reduce transmission of *Cryptosporidium* in treated recreational water venues. First, adoption of improved disinfection technologies that inactivate *Cryptosporidium* might reduce exposure to and viability of infectious oocysts. Second, increased public awareness of healthy swimming practices might reduce the number of persons who swim while ill with diarrhea, thereby reducing the risk for fecal contamination.

Reducing the risk for future outbreaks will require changes in pool-water disinfection practices. Supplementary disinfection known to inactivate *Cryptosporidium*, such as in-line ultraviolet radiation or ozone systems, can add an additional level of protection for swimmers by decreasing the duration of oocyst transmission (*4,7*). Because both technologies depend on water recirculation rates, oocysts remain viable until all pool water has been treated, which can require up to 24 hours. The swimming pool implicated in the Colorado outbreak was the only recreational water venue in the outbreaks described in this report that used ultraviolet radiation to treat recirculated water; however, determining whether the presence of supplemental disinfection resulted in fewer cases than would have occurred otherwise is not possible. Further risk reduction might be achieved through use of increased circulation flow rates, flocculants, remedial biocidal shock treatments (e.g., routine hyperchlorination: 20 ppm for 8 hours or equivalent), and occupancy-dependent water replacement.

Public education should reinforce the message that swimming pool patrons share responsibility for controlling the spread of *Cryptosporidium* in recreational water venues and encourage the public to be proactive regarding prevention of illness. Messages should stress refraining from swimming while ill with diarrhea, not swallowing pool water, practicing good hygiene, and reporting fecal contamination to pool operators so that appropriate disinfection can be administered (*8*). Additionally, during recognized outbreaks of cryptosporidiosis, increased public and media communication should be initiated to decrease the possibility of communitywide transmission (Box), and swimmers should refrain from swimming for 2 weeks after diarrhea has resolved because of continued shedding of the parasite (*9*).

A multifaceted approach for prevention of cryptosporidiosis in treated water venues must address operational, technological, and behavioral factors related to recreational water use. A national program to develop a model aquatic health code and risk-reduction plan has been initiated by CDC and partners in the public health and aquatic sectors. Additional information is available at http://www.cdc.gov/healthyswimming.

References

1. Dillingham RA, Lima AA, Guerrant RL. Cryptosporidiosis: epidemiology and impact. Microbes Infect 2002;4:1059--66.
2. CDC. Cryptosporidiosis surveillance, United States, 1999--2002. MMWR 2005;54(No. SS-1):1--18.
3. CDC. Preliminary FoodNet data on the incidence of infection with pathogens transmitted commonly through food---10 states, 2006. MMWR 2007;56:336--9.
4. Korich DG, Mead JR, Madore MS, Sinclair NA, Sterling CR. Effects of ozone, chlorine dioxide, chlorine, and monochloramine on *Cryptosporidium parvum* oocyst viability. Appl Environ Microbiol 1990;56:1423--8.
5. CDC. Surveillance for waterborne disease and outbreaks associated with recreational water---United States, 2003--2004. MMWR 2006;55(No. SS-12):1--30.
6. Xiao L, Fayer R, Ryan U, Upton SJ. *Cryptosporidium* taxonomy: recent advances and implications for public health. Clin Microbiol Rev 2004;17:72--97.
7. Bukhari Z, Clancy JL, Hary TM, Bolton J, Dussert B, Marshall MM. Medium-pressure UV for oocyst inactivation. J Am Water Works Assoc 1999;91:86--94.
8. CDC. Responding to fecal accidents in disinfected swimming venues. MMWR 2001;50:416--7.
9. Jokipii L, Jokipii AM. Timing of symptoms and oocyst excretion in human cryptosporidiosis. N Engl J Med 1986;315:1643--7.

* Aquatic entertainment facilities typically containing water slides, wave pools, "lazy rivers," or interactive fountains.

Box

BOX. Recommendations to reduce the risk for communitywide spread of cryptosporidiosis during outbreaks associated with recreational water venues

Public health officials should consider issuing the following recommendations:

To the general public

- Do not swim while experiencing a diarrheal illness and for 2 weeks after diarrhea resolves.
- Avoid swallowing pool water.
- Practice proper hygiene, including handwashing after using restroom or changing diapers and showering before entering recreational water.
- Access http://www.cdc.gov/healthyswimming for prevention information.

To health-care providers

- Report cases of cryptosporidiosis to the local health department, as required.
- Collect stool samples and request *Cryptosporidium* testing, when indicated.
- Remind patients to refrain from swimming while ill with diarrhea and for 2 weeks after cessation of diarrhea.
- Remind parents that children with diarrheal illness should not enter the water at recreational water facilities.

To pool operators

- Initiate hyperchlorination protocols for *Cryptosporidium* (available at http://www.cdc.gov/healthyswimming).
- Place diarrhea exclusion messages at pools, with alerts about any outbreaks.
- Prohibit pool staff with diarrhea from entering pool.
- Consider suspending swim classes and other group events.
- Consider suspending visits by large day care center groups.
- Do not close pool without consulting with public health authorities because previous investigations have demonstrated that patrons are likely to swim elsewhere and contaminate other swimming venues.

Return to top.

Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.

References to non-CDC sites on the Internet are provided as a service to *MMWR* readers and do not constitute or imply endorsement of these organizations or their programs by CDC or the U.S. Department of Health and Human Services. CDC is not responsible for the content of pages found at these sites. URL addresses listed in *MMWR* were current as of the date of publication.

**Questions or messages regarding errors in formatting should be addressed to mmwrq@cdc.gov.

Date last reviewed: 7/26/2007

SAFER·HEALTHIER·PEOPLE™
Morbidity and Mortality Weekly Report
Centers for Disease Control and Prevention
1600 Clifton Rd, MailStop E-90, Atlanta, GA 30333, U.S.A

USA.gov Government Made Easy

Department of Health and Human Services