Cryptosporidiosis
Outbreak at a
Summer Camp—
North Carolina, 2009

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1 figure, 1 table omitted

In July 2009, local, regional, state, and federal public health officials investigated a cryptosporidiosis outbreak at a youth summer camp in North Carolina. The investigation identified 46 laboratory-confirmed and probable cryptosporidiosis cases at the camp. Analyses of data from a retrospective cohort study of staff members revealed that eating ham from a sand-wich bar that included camp-grown raw produce and sharing a cabin with an ill person were significantly associated with illness. Cryptosporidium isolates from stool specimens of livestock and humans at the camp were of the identical Cryptosporidium parvum subtype, IIaA17G2R1, indicating that zoonotic transmission had occurred, and suggesting a link not implicated by traditional epidemiologic methods. This investigation underscores the importance of reducing the risk for Cryptosporidium transmission in camp settings and the value of Cryptosporidium subtyping as a tool to elucidate cryptosporidiosis epidemiology.

On June 24, owners of a North Carolina youth summer camp and health-care providers began identifying cases of diarrhea in campers and staff members and notified local public health officials. By June 30, local, regional, and state public health officials had identified four laboratory-confirmed cases of cryptosporidiosis and >30 cases of diarrhea at the camp. CDC was asked to collaborate on the investigation because no common outbreak exposure was identified and multiple potential outbreak sources were present at the camp. The investigation focused on identifying risk factors associated with acute cryptosporidiosis and implementing control measures to stop Cryptosporidium transmission at the camp.

Cryptosporidiosis is a diarrheal illness caused by the parasite Cryptosporidium. Fecal-oral transmission of Cryptosporidium oocysts can occur via ingestion of contaminated recreational water, drinking water, or food, or via contact with infected persons or animals, most notably preweaned calves. Potential routes of transmission at the camp included several recreational water venues (a swimming pool, lake, and river), drinking water supplied by wells, meals served by a central kitchen, and a garden that provided >50% of the produce for camp meals. Multiple animals, with which campers and staff members had contact, were kept at the camp, including cows, goats, and pigs. Ten Jersey and 12 Holstein preweaned calves arrived at the camp on May 29 and June 13, respectively.

For this investigation, a case was defined as probable if the ill person (1) had been at the camp during June 20-26, 2009, and (2) had onset of gastrointestinal symptoms (including diarrhea, defined as three or more loose or watery stools in 24 hours) after June 21, 2009. Confirmed cases were defined as meeting those conditions and having laboratory-based evidence of Cryptosporidium infection. Human and animal stool specimens were tested for Cryptosporidium, and isolates were subtyped using DNA sequence analysis. In response to anecdotal reports of bloody diarrhea, stool specimens also were tested for bacterial pathogens.

A total of 46 cases were identified; 12 confirmed and 34 probable. The unimodal epidemic curve peaked on June 26-27 (Figure). Cryptosporidium was detected in stool specimens from 12 patients. C. parvum was detected in stool specimens from one (10%) of 10 Jersey calves, two (17%) of 12 Holstein calves, one goat kid (33%) of three goats, and one piglet (50%) of two pigs. C. parvum isolates from seven humans and all but one of the animals were of the identical C. parvum subtype, IIaA17G2R1. Shiga toxin—producing Escherichia coli serogroup O111 strains were detected in stool specimens of one patient and five calves; the pulsed-field gel electrophoresis (PFGE) pattern of the human E. coli isolate did not match any of the three PFGE patterns found in the calf isolates.

A retrospective cohort study enrolled staff members only; campers, who were as young as age 5 years, were excluded because of concerns about recall accuracy and because they had minimal variation in their camp activities. The self-administered study questionnaire asked about clinical symptoms and approximately 160 camp-specific exposures and individual food items. All risk factors in bivariate analysis with p-values <0.05 were considered for inclusion in the multivariable model. Because data were sparse and many risk factors were assessed, the final multivariable model was constructed using stepwise selection, starting with the variable with the smallest p-value and adding variables one by one. The final model included only significant (p<0.05) covariates.

Of 129 staff members, 123 (95%) completed the retrospective cohort study questionnaire (Table). In multivariable analysis, only two factors were significantly associated with illness: ham from the sandwich bar on June 21 (adjusted prevalence ratio [aPR] = 3.5; 95% confidence interval [CI] = 1.6-7.4) and sharing a cabin with an ill person (aPR = 2.8; CI = 1.3-6.2).

A simultaneous environmental health investigation included inspection of the camp and collection of samples from all camp water sources, including the pool, lake, creeks, river, wells, produce preparation sink, and ice-maker filter, and composite soil samples from the gardens for Cryptosporidium testing. The investigation revealed that persons were encouraged to spray a diluted bleach solution on their hands before and after interacting with the calves, but a hand-washing sink was not available in the
barn area. Cryptosporidium spp. were detected in multiple composite soil samples from the gardens; however, components of the soil inhibited DNA amplification and precluded typing of Cryptosporidium isolates. Cryptosporidium was not detected in any of the water samples. After the outbreak began, the camp implemented control measures, including installing a hand-washing sink in the barn area.

Findings from previously reported cryptosporidiosis outbreaks at camps with calves present have indicated that visible manure on hands was associated with illness; conversely, habitual hand washing with soap after calf contact was protective. Along with hand washing, additional measures to protect against transmission of Cryptosporidium in camp settings are needed (Box).

**Box. Key recommendations for camp owners and managers to help prevent and control transmission of Cryptosporidium**

**Hand washing**
- Provide appropriate and accessible hand hygiene stations with running water, soap, and disposable towels or air dryers. Alcohol-based hand sanitizers are not effective against Cryptosporidium.
- Hands should be washed:
  - Before, during, and after preparing food and beverages
  - Before eating food
  - Before and after caring for someone who is ill
  - After using the toilet
  - After cleaning up a person who has used the toilet
  - After touching an animal or an animal’s manure or environment (e.g., a stall)
  - After removing clothing or shoes that might be soiled by animal waste
  - After touching garbage
- Steps on how to properly wash hands are described at [http://www.cdc.gov/handwashing](http://www.cdc.gov/handwashing).

**Animals**
- Consider limiting contact with preweaned calves.

**Food**
- Maintain food services to the standards set by local or state laws.
- Exclude persons from food and beverage preparation if they are ill with diarrhea or other gastrointestinal symptoms.

*Additional recommendations for camp facilities to prevent Cryptosporidium transmission are available at [http://www.cdc.gov/parasites/crypto/camps.html](http://www.cdc.gov/parasites/crypto/camps.html).*

The findings in this report are subject to at least four limitations. First, the study questionnaire did not ask respondents about raw produce added to their sandwiches on June 21. Second, only 26 cases were included in the cohort.

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What is already known on this topic?

Cryptosporidium is an extremely chlorine-tolerant parasite that causes cryptosporidiosis, a common cause of diarrhea in the United States. Fecal-oral transmission of Cryptosporidium can occur via ingestion of contaminated recreational water, drinking water, food, or via contact with infected persons or animals, most notably preweaned calves.

What is added by this report?

Traditional epidemiologic methods indicated food and person-to-person contact were significantly associated with illness. However, Cryptosporidium subtyping results indicated the source of the outbreak was likely to be preweaned calves, a source that was not implicated by traditional epidemiologic methods.

What are the implications for public health practice?

Camps where animals are kept need to enforce effective hygiene and sanitation practices to prevent Cryptosporidium transmission. A national program that systematically subtypes Cryptosporidium isolates could elucidate the epidemiology of cryptosporidiosis in the United States.

study, limiting statistical power. Third, persons with preexisting Cryptosporidium antibodies might be less likely to develop illness upon reinfection, introducing possible misclassification of illness status and biasing estimates of association between exposure and illness toward the null. Finally, this association between exposure and illness status and biasing estimates of introducing possible misclassification of

REFERENCES

10 Available.

*Commercial laboratories detected Cryptosporidium spp. in stool specimens of five patients. These five stool specimens had been discarded, and isolates were not available for confirmatory testing and Cryptosporidium subtyping unlike the remaining seven. 15Stool specimens from only four of the seven patients with laboratory-confirmed C. parvum infection were tested for bacterial pathogens. 4Although dilute bleach solution might effectively disinfect chlorine-susceptible pathogens such as E. coli, it would not be an effective disinfectant for Cryptosporidium, which is extremely chlorine-tolerant.

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