Cryptosporidiosis in Georgia

A Classroom Case Study

STUDENT'S VERSION

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Note: *This case study is based on a real-life outbreak investigation undertaken in Georgia in 1987.*[1] *Certain aspects of the original outbreak and investigation have been altered, however, to assist in meeting the desired teaching objectives and to allow completion of the case study within the allotted time.*

Students should be aware that this case study describes and promotes one particular approach to outbreak investigation; however, procedures and policies in outbreak investigation can vary by country, state, and outbreak.

The developers of this case study anticipate that the majority of outbreak investigations will be undertaken within the framework of an investigation team that includes persons with epidemiology, microbiology, and environmental health expertise. Through the collaborative efforts of this team, with each member playing a critical role, outbreak investigations are successfully completed.

Please send us your comments on this case study by visiting our Internet site at http://www.cdc.gov/epicasestudies. Include the name of the case study with your comments and be as specific as possible about the applicable location of comments or suggested edits.

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Public Health Service
Centers for Disease Control and Prevention
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Learning Objectives:

After completing this case study, the student should be able to

1. discuss epidemiologic clues indicative of a waterborne disease outbreak as opposed to a foodborne disease outbreak;
2. describe a boil-water advisory and discuss problems that might be encountered in issuing such an advisory;
3. help plan a community survey to determine the prevalence and distribution of a health problem;
4. interpret a dose-response analysis for an exposure and development of a disease;
5. list activities that should be included in the evaluation of a public water system associated with an outbreak;
6. define turbidity and total coliform count and discuss how each are used to indicate drinking water quality;
7. discuss the typical steps used in the treatment of surface water at a community water treatment plant; and
8. describe the clinical features, epidemiology, and control of cryptosporidiosis.

PART I. OUTBREAK DETECTION

On January 21, a physician notified the Georgia Department of Human Resources (GDHR) of a dramatic increase in acute gastroenteritis among students at a college in Carrollton, Georgia. (Carrollton is a small town located in western Georgia [population estimate: 16,250] and is the county seat of Carroll County [population estimate: 64,900].)

The physician reported examining hundreds of students with a gastrointestinal illness at the college's infirmary during the previous week. The majority of students reported having abdominal pain and watery diarrhea of several days duration.

Typically, approximately 100 students were examined at the infirmary each day, the majority of whom presented with upper-respiratory infections or injuries. On January 20 alone, over 200 students were examined at the infirmary for gastroenteritis.

Question 1: Do you think these cases of gastrointestinal illness represent an outbreak at the college? Why or why not?

The physician reported that stool specimens had been collected from selected ill students and had been submitted to the hospital laboratory for testing. Because the physician had an interest in parasitology, he had specifically requested that the stools also be examined for parasites.

The physician reported that cultures for bacterial pathogens had been negative. On microscopic examination, four specimens were determined to be positive for *Cryptosporidium*. The earliest known onset of illness among the *Cryptosporidium*-positive students was January 11.

Question 2: How is cryptosporidiosis transmitted? On what sources of infection should public health officials focus? (See Appendix A for additional information about cryptosporidiosis.)

Staff from GDHR contacted the Carroll County Health Department about the outbreak. Because the majority of the ill students lived on campus and participated in the university meal plan, concerns were voiced regarding possible foodborne transmission of the infection at the college. Within a few hours of the initial report, an environmental health specialist from the Carroll County Health Department was dispatched to the college to interview food service staff and to inspect the kitchen at the main cafeteria for food safety problems.

Meanwhile, staff from GDHR undertook steps to determine whether the cryptosporidiosis problem extended beyond the college.

Question 3: What existing sources of information might help determine if others in the community have cryptosporidiosis?

A review of the patient intake log from the local hospital emergency department provided evidence of an increase in patients presenting with gastrointestinal illness starting the week of January 11. However, the majority of these patients were not students from the college. Calls to selected public schools and large businesses in Carroll County revealed widespread absenteeism. In addition, data from local pharmacies indicated an increase in sales of antidiarrheal medications throughout the county.

On the basis of these findings, staff from GDHR and the Carroll County Health Department concluded that the outbreak was not confined to the college but involved the entire Carroll County community. Reports from three communities bordering Carroll County indicated that those areas were not severely affected.

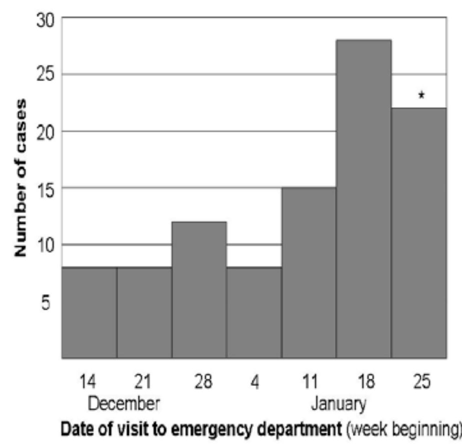
PART II. DESCRIPTIVE EPIDEMIOLOGY AND HYPOTHESIS GENERATION

To characterize the cryptosporidiosis cases and to seek clues about the source of the Carroll County outbreak, investigators from GDHR examined medical records from patients with acute gastroenteritis examined at the local hospital's emergency department.

During December 14 though January 25, a total of 98 patients were examined at the emergency department for acute gastroenteritis. The number of visits increased from 8−12 each week through the first week of January to 22−28 each week during the last 2 weeks of January (Figure 1).

Among the 65 patients with acute gastroenteritis examined at the emergency department since January 11, when the first *Cryptosporidium*-positive student had onset of illness, the following symptoms were reported: diarrhea (defined as three or more loose stools/day) (87%), stomach pain (80%), nausea (67%), vomiting (33%), fever (30%), and muscle aches (20%). Patients often reported that their diarrhea was watery. Approximately half of patients reported that their symptoms had been present for more than a week at the time they presented to the emergency department.

Figure 1. Numbers of visits by patients with acute gastroenteritis, local emergency department. Carroll County. Georgia by week of visit, December and January.



*Reporting for the week beginning January 25 was not complete

Patient's ages ranged from younger than a year to 76 years (mean: 34 years); 63% of patients were female. The majority of the patients lived within Carrollton's city limits as opposed to other parts of the county outside the city. Cases did not appear to cluster by neighborhood of residence, child care center, or school but were widely distributed around the city. Information on specific exposures was unavailable.

Stool specimens, available from 25 patients, were forwarded to the Centers for Disease Control and Prevention (CDC) for examination. *Cryptosporidium* was identified in 11 (44%) of the 25 specimens. One stool from a child aged 2 years was also positive for *Giardia*.

Question 4: Interpret the descriptive epidemiology of the outbreak including the epidemic curve (Figure 1). Were symptoms among patients consistent with cryptosporidiosis? Was clustering of cases by selected demographic characteristics apparent? What was the course of the outbreak and did it appear to be over?

Because of the wide geographic distribution of cases within the Carrollton's city limits and the occurrence among all age groups, water was suspected as a possible source of the outbreak. Investigators reviewed public water system records and collected water specimens from multiple points in the water distribution system.

Routine total coliform counts from water samples collected from the public water system on January 5 were negative. In addition, samples of water collected from the college in Carrollton on January 22 and the public water system on January 23 were also negative for coliforms.

Question 5: What do total coliform counts indicate? What does a negative total coliform in treated water mean?

Investigators contacted the directors of the four nursing homes in the Carrollton area. The three nursing homes connected to the public water supply reported substantial numbers of residents with acute gastroenteritis. The nursing home that used a well for their water supply reported no residents with acute gastroenteritis.

On the basis of this information, the Carroll County Health Department issued a boil-water advisory on January 25.

Question 6: What is a boil-water advisory? How would you go about implementing one? What actions might improve the effectiveness of such an advisory?

Question 7: What studies or investigations might you undertake to confirm the hypothesis that the public water supply was the source of Carrollton's cryptosporidiosis outbreak?

PART III. DESIGNING AN EPIDEMIOLOGIC STUDY TO TEST THE HYPOTHESIS

On January 25, a case-control study was undertaken among patients presenting at the local hospital emergency department. Case-patients were persons who had presented to the emergency department with abdominal pain or diarrhea (defined as three or more loose stools in a 24-hour period) since January 1. Control-subjects were patients presenting to the emergency department on the same dates as the case-patients but for non-gastrointestinal illnesses.

Twenty (80%) of 25 case-patients and 3 (33%) of 9 control subjects had been exposed to the public water supply at home or work (odds ratio: [OR] 8; P value = 0.03). The case-control study, however, was plagued with problems. Multiple patients initially selected as control subjects, but who were later excluded, reported having been ill with abdominal pain and diarrhea even though they had been examined at the emergency department for non-gastrointestinal illnesses.

Investigators questioned the validity of the results. Therefore, two simultaneous lines of investigation were undertaken to determine if the public water supply was the source of the outbreak: a community survey and an evaluation of the water treatment plant in Carrollton, Georgia.

Staff from the Carroll County Health Department met with epidemiologists from the Georgia Department of Human Resources to plan the community survey.

Question 8: What steps would you undertake to conduct a community survey?

The goals of the community survey were to determine the number of persons affected by cryptosporidiosis in Carroll County and to examine the association between public water consumption, other possible risk factors, and gastrointestinal illness.

Question 9: How would you select a sample for the survey?

To select the survey sample investigators systematically selected 400 listings (i.e., households) from the Carroll County telephone directory that listed Carrollton telephone numbers separately from those outside Carrollton. A larger proportion of Carrollton telephone numbers were selected (i.e., were oversampled) to ensure that the sample included an adequate number of persons who had been exposed to the public water supply (i.e., the suspected source of the outbreak).

A GDHR epidemiologist drafted a questionnaire for the survey. The questionnaire was piloted with staff from the Carroll County Health Department who were not involved in the investigation.

Question 10: How would you collect information from selected households for the survey?

Information for the survey was to be collected through telephone interviews. By using the questionnaire developed by the GDHR epidemiologist, one adult in each selected household (referred to as the respondent) was to be asked his or her age and sex, place of employment (or school), food and restaurant exposure, home water source, amount of tap water consumed, consumption of ice, and exposures to children in child care centers and to farm animals. The respondent also was to be asked about the age, sex, and place of employment or school of all household members and whether the household member had been ill with abdominal pain or diarrhea (defined as three or more loose stools within a 24-hour period) since January 1.

On the afternoon of January 30, a total of 12 staff from GDHR and the Carroll County Health Department were trained to administer the survey questionnaire by telephone. Starting that evening, they telephoned each household on the list.

Question 11: What activities or efforts might help to improve the survey response rate?

PART IV. ANALYSIS AND INTERPRETATION OF EPIDEMIOLOGIC RESULTS

By February 5, adult respondents were interviewed at 304 (76%) of the 400 telephone numbers. Fifty-six of the listings were disconnected numbers; 31 had no answer after three calls or had no adult available to complete the interview; and nine adult respondents refused to participate or did not complete the interview. Information was collected from the 304 adult respondents and 507 additional household members for a total of 811 household members.

Investigators calculated the overall attack rate among all household members and attack rates by residence and exposure to the public water supply. Investigators set a P value of 0.05 as the cutoff for statistical significance. The source of home water was based on information provided by the adult respondent from each household. County engineers determined the water supply for worksites and schools. Persons whose home, school, or worksite was supplied with public water were considered to have been exposed to the public water supply.

Of the 811 household members interviewed, 363 had been ill with abdominal pain or diarrhea (defined as three or more loose stools within a 24-hour period) since January 1. After adjusting for oversampling of households from Carrollton, the overall attack rate for the county was 40%. Attack rates varied by residence and exposure to the public water supply (Table 1).

Table 1. Occurrence of illness* by exposure among all household members, community survey, Carroll County, Georgia.

Exposure	Illness among exposed	Illness among not exposed	Relative risk	95% confidence interval	P value
Residence in Carrollton	293/543 (54%)	70/278 (25%)	2.2	1.7−2.5	<0.0001
Exposure to public water supply	299/489 (61%)	64/322 (20%)	3.1	2.4−3.9	<0.0001

*Abdominal pain or diarrhea (defined as three or more loose stools within a 24-hour period) since January 1.

Among the 489 household members exposed to the public water supply, the attack rate was 67% for females and 55% for males (relative risk: 1.2; 95% confidence interval 1.1−1.4; P value=0.01). Attack rates varied by age group, ranging from 52% to 72%. The highest attack rate was among persons aged 20−29 years, but these differences were not statistically significant.

Question 12: Interpret the survey findings.

Among the 304 adult respondents to the survey, 182 were exposed to the public water supply and provided information on the average amount of water they consumed each day (Table 2).

Table 2. Occurrence of illness* among adult respondents exposed to the public water supply by average amount of water consumed a day, community survey, Carroll County, Georgia.

Average number of 8-ounce glasses of water consumed/day	Number ill	Number exposed	Attack rate
<1	2	11	18%
1−2	17	38	45%
3−4	28	48	58%
5−6	15	31	48%
7−8	21	25	84%
>8	26	29	90%
Total	109	182	60%

*Abdominal pain or diarrhea (defined as three or more loose stools within a 24-hour period) since January 1.

Question 13: Graph and interpret the association between water consumption and the occurrence of illness

Among adult respondents exposed to the public water supply, the higher attack rate among females remained significant even after controlling for age and water consumption. No significant association was identified between illness and any other exposure studied (e.g., exposure to specific foods, child care centers, farm animals, or other ill persons).

Question 14: On the basis of Table 1, 20% of persons not exposed to the public water supply became ill. If the public water supply was the source of the outbreak, what explanations exist for these persons becoming ill?

PART V. ENVIRONMENTAL STUDIES AND WATER INVESTIGATION

On January 25, an evaluation of the Carrollton water system was initiated by federal and local engineers.

Question 15: What activities would you include in the evaluation of a public water treatment plant? With whom would you talk? What records or data sources would you review?

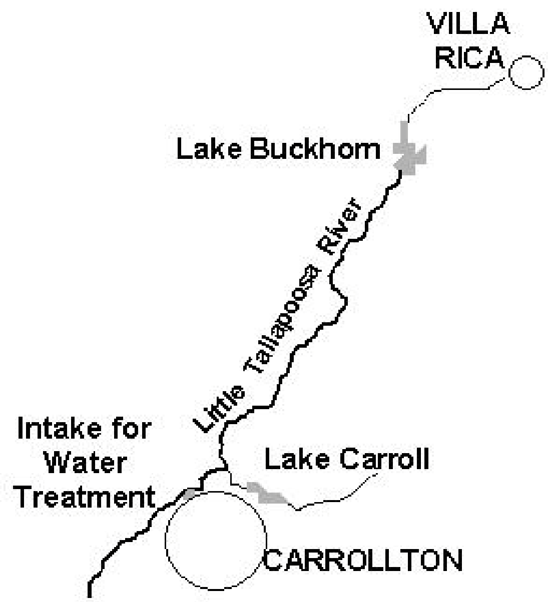
The engineers met first with the water system superintendent. The superintendent began by describing the source of water for the public water supply.

The Carrollton water system drew surface water from the Little Tallapoosa River and two reservoirs (Figure 2). The river begins near the town of Villa Rica and flows in a southwesterly direction to Carrollton, predominantly through hayfields and pastureland. Lake Buckhorn was used to supplement city water supplies when necessary. The city had no restrictions on the recreational uses of this reservoir and did not control a buffer strip around the reservoir.

The city raw water intake and pump were located on the northwest side of Carrollton. Lake Carroll, on the northeast side of Carrollton, acted as water storage impoundment for the water system. Water was drawn from Lake Carroll during periods of drought and high demand.

The water system superintendent showed the engineers a blueprint of the plant and led them on a tour of the treatment facility. The engineers interviewed the six plant operators and a maintenance technician to learn about water treatment operations at the facility.

Figure 2. Diagram of the Little Tallapoosa River between Villa Rica and Carrollton, Georgia.

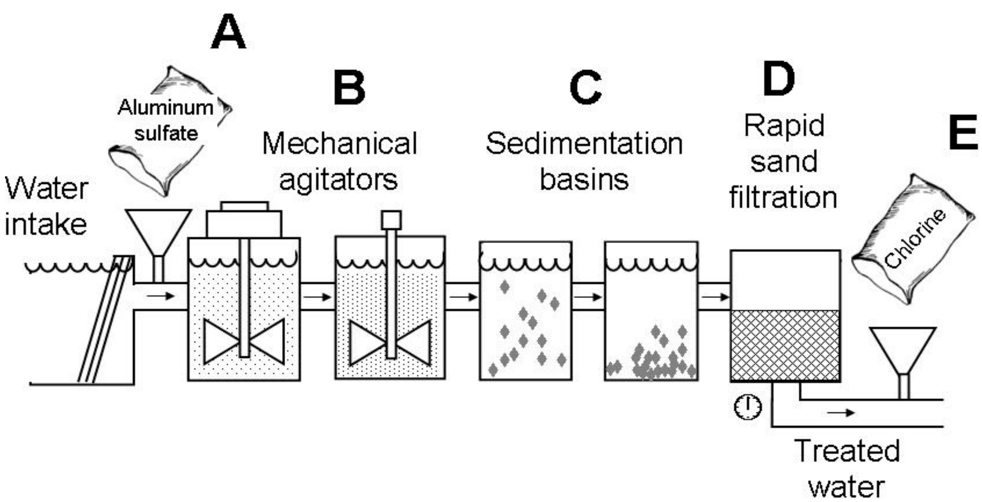


Question 16: What are the typical steps in the treatment of surface water at a public water treatment plant?

Water at the Carrollton water system was initially treated by adding a coagulant, aluminum sulfate (Figure 3A). The coagulant caused smaller particles in the water to aggregate into larger particles (called floc) that were more likely to settle out. Addition of the aluminum sulfate was followed by rapid mixing by using mechanical agitators to promote the aggregation of particulates (Figure 3B). The aggregated particles were allowed to settle out in a sedimentation basin (Figure 3C). The water was then filtered by using rapid sand filtration (Figure 3D).

Chlorine in the form of powdered calcium hypochlorite was added to the filtered water in predetermined amounts by using an automatic feed pump (Figure 3E). The chlorine was fed directly into a retention tank along with the water so that chlorine concentration and contact time could be controlled before it was released into the distribution system. Lime was also added to the water to minimize leaching of lead and copper in home plumbing systems.

Figure 3. Diagram of Carrollton water treatment process.



From Hayes EB, Division of Parasitic Diseases, CDC, Personal Communication, 1989.

On the basis of information provided by the plant operators, 10−20 rapid sand filters were in operation at the water treatment plant at any one time, depending on water demand. The filters were cleaned on a routine basis by using backwashing, a process that involved reversing the flow of water back through the filter to remove the solids trapped in the filter media and allowing the filters to sit for a period before being placed online (i.e., were allowed to ripen). All backwash water was diverted to sewage.

Filters that had been taken offline were also backwashed before being restarted. Starting filters without backwashing can discharge dirt, aggregated particles, and microorganisms from the filter beds into the treated water.

The engineering evaluation revealed multiple deviations from normal operations at the Carrollton water system during the prior 2 months. Mechanical agitators had been removed in December in anticipation of a scheduled replacement but still had not been replaced. Filters were sometimes restarted without first being backwashed. During the first week of January, the number of filters restarted increased from a weekly average of 22 to 38 because water use increased when students returned to the college after the holidays.

The engineers reviewed plant water-quality data (e.g., records of pH, temperature, turbidity, and total coliform counts) of untreated and treated water. They measured the turbidity of the water at the intake and the outflow from the facility and collected samples of raw and treated water to test for coliforms and *Cryptosporidium*.

Question 17: What does turbidity indicate? Why would the investigators be interested in turbidity of both untreated and treated water?

On the basis of water-quality records, treated water from the Carrollton water system was at all times in compliance with U.S. Environmental Protection Agency and state of Georgia limits for turbidity, coliform bacteria, and free chlorine residual. At the time of the outbreak, federal guidelines required that turbidity not exceed 5 nephelometric turbidity units (NTUs) on any one reading or exceed 1 NTU in more than 5% of the daily samples in any month. For this size water system, total coliforms were tested on a monthly basis.

Treated water samples obtained from the water system during the engineering evaluation had turbidity ranging from 0.1 to 0.5 NTUs. These samples, however, demonstrated that particles as large as 100 μm were passing into the town's water supply. All samples collected during the evaluation were negative for total coliforms.

Cryptosporidium oocysts were identified in samples of treated water taken from the treatment plant and from four dead-end water mains (i.e., mains that supply water from only one direction such that water stops circulating and becomes stagnant), including one at the college first reporting the outbreak.

Question 18: How is it possible that treated water from the public water system was negative for coliforms yet contained *Cryptosporidium* oocysts?

Samples obtained on February 4−5 from Lake Carroll and streams that drained into the Little Tallapoosa River above the treatment plant were positive for *Cryptosporidium* but samples taken from the river itself, upstream from the treatment plant, were negative. Samples of treated water taken as controls from a nearby town with a separate water source were also negative.

Fresh stool samples were collected from 67 of 226 cattle (including three calves) pastured in the watershed of the Little Tallapoosa River. No outbreaks of diarrheal illness were reported in regard to these cattle. *Cryptosporidium* was present in stool samples obtained from 3 of the 67 cattle tested. Because of the low level of infection among cattle in Carroll County and the discordant distribution of positive cattle fecal samples and positive water sample sites, investigators could not conclude that the outbreak was caused by cryptosporidiosis among the cattle.

On the basis of data provided by the National Weather Service, environmental conditions at the time of the outbreak might have increased the level of surface water contamination. Approximately 10 inches (25 cm) of rain and snow had fallen during January 15−22, raising the possibility of surface runoff.

Furthermore, a sewage pipe overflow was discovered in mid-February in a wooded area above the water treatment plant. The duration of the overflow, caused by a blocked major sewer line, could not be determined. When dye was released at the overflow point, it reached the Little Tallapoosa River and the water treatment plant in approximately 6 hours. The sewage spill might have augmented the load of *Cryptosporidium* reaching the water treatment plant.

PART VI. CONTROL AND PREVENTION MEASURES

On February 6, the Carrollton water system superintendent and plant operators met with federal and local engineers to determine what steps were necessary to ensure the safety of the public water supply and to lift the boil-water advisory.

Question 19: What water treatment measures are effective against *Cryptosporidium*?

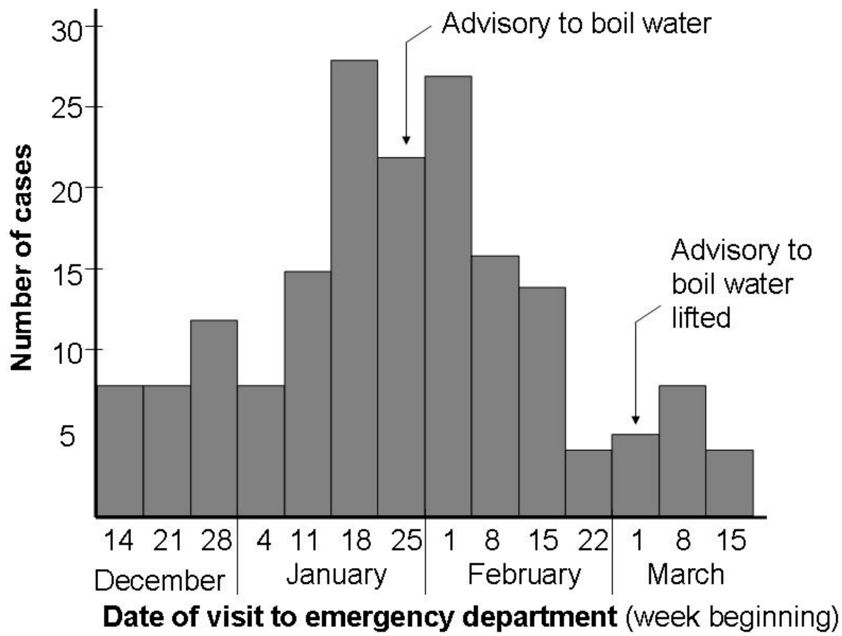
The water treatment facility installed the missing mechanical agitators and upgraded their turbidity-monitoring equipment. The new equipment measured turbidity continuously throughout each day on each filter, recording readings at 15-minute intervals. An alarm sounded and the system automatically shut down if the turbidity of filtered water exceeded 0.3 NTU. Total coliform counts were monitored daily.

Plant employees were reminded of the need to backwash filters before restarting them and the plant operators were to ensure that procedures were followed. The blocked sewer line was repaired and the sewage spill was cleaned up. In addition, the entire water system was flushed in an attempt to remove residual oocysts.

Question 20: How would you monitor the effectiveness of these control measures?

Local clinicians were encouraged to test patients for *Cryptosporidium* if a patient experienced acute gastroenteritis and had symptoms for longer than 3 days. The number of visits for gastroenteritis at the local hospital emergency department returned to baseline (Figure 4).

Figure 4. Numbers of emergency department visits by patients with acute gastroenteritis, Carroll County, Georgia, by week of visit, December−March.



Changes at the water treatment facility improved the turbidity of treated water, consistently removing particles larger than approximately 1 micrometer. *Cryptosporidium* oocysts are approximately 3−4 µm in size. A sample of water taken on February 11 revealed no oocysts. The consistently low turbidity readings resulted in the lifting of the boil-water advisory on March 2.

For a complete report of the investigation of the cryptosporidiosis outbreak in Carrollton, Georgia, see NORS Report_Cryptosporidiosis Outbreak in Georgia.pdf (i.e., the CDC 52.12 report that was completed for the outbreak).

EPILOGUE

Public water systems are regulated under the Safe Drinking Water Act (SDWA) of 1974 and its subsequent 1986 and 1996 amendments.[2] The act authorizes the EPA to set national standards to protect public drinking water and its sources against naturally occurring or manmade contaminants. Information reported on waterborne outbreaks through CDC's Waterborne Disease and Outbreaks Surveillance System is used, in part, to assess whether EPA regulations for water treatment and water-quality monitoring are adequate to protect the public's health.[3-7]

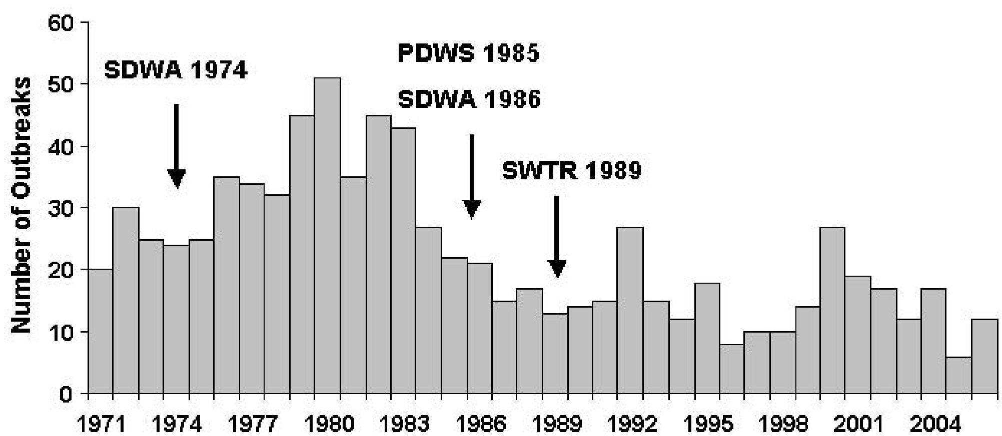
Before the Carrollton outbreak, *Cryptosporidium* had been linked only with waterborne outbreaks in communities using unfiltered surface water for drinking. The outbreak in Carrollton was the first reported contamination of a filtered surface water system. Although the sand filtration and chlorination used at the water treatment facility met all water-quality standards at the time, suboptimal mechanical agitation and filtration probably allowed the parasite to pass into the drinking water supply.

A similar outbreak occurred in 1993 in the greater Milwaukee area in which more than 400,000 persons were affected. In the Milwaukee outbreak, *Cryptosporidium* oocysts in untreated surface water from Lake Michigan entered the water treatment plant where existing coagulation and filtration methods allowed them to enter the public water supply. [8] As with the Carrollton outbreak, water quality measures for the treated water were within EPA required limits.

These outbreaks, along with others, demonstrated that *Cryptosporidium* can contaminate filtered public water systems, even when the water quality is within regulatory limits for coliform bacteria, chlorine, and turbidity. This realization prompted EPA to reconsider water treatment regulations and the issuance of Interim Enhanced Surface Water Treatment Rule (IESWTR) 63 FR 69478–69521(December 16, 1998, Vol. 63, No. 241). This rule increased turbidity performance standards for public water treatment systems and increased the frequency of monitoring requirements.[9]

The increasingly stringent EPA regulations for treatment of surface water have had a positive effect on the safety of treated drinking water in the United States. Since the early 1990s, the number of reported waterborne outbreaks associated with either untreated or inadequately treated surface water has decreased substantially (Figure 5).

Figure 5. Number of waterborne-disease outbreaks associated with drinking water (n = 814), by year — United States, 1971–2006.



Source: CDC Waterborne Disease and Outbreak Surveillance System
SDWA = Safe Drinking Water Act; PDWS = National Primary Drinking Water Standards; SWTR=Surface Water Treatment Rule.

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ADDITIONAL RESOURCES

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APPENDIX A: CDC Cryptosporidiosis Fact Sheet

Available at http://www.cdc.gov/crypto/gen_info/infect.html

What is cryptosporidiosis?
Cryptosporidiosis is a diarrheal disease caused by microscopic parasites, *Cryptosporidium*, that can live in the intestine of humans and animals and is passed in the stool of an infected person or animal. Both the disease and the parasite are commonly known as "Crypto." The parasite is protected by an outer shell that allows it to survive outside the body for long periods of time and makes it very resistant to chlorine-based disinfectants. During the past 2 decades, Crypto has become recognized as one of the most common causes of waterborne disease (recreational water and drinking water) in humans in the United States. The parasite is found in every region of the United States and throughout the world.

How is cryptosporidiosis spread?
Cryptosporidium lives in the intestine of infected humans or animals. An infected person or animal sheds Crypto parasites in the stool. Millions of Crypto germs can be released in a bowel movement from an infected human or animal. Shedding of Crypto in the stool begins when the symptoms begin and can last for weeks after the symptoms (e.g., diarrhea) stop. You can become infected after accidentally swallowing the parasite. *Cryptosporidium* may be found in soil, food, water, or surfaces that have been contaminated with the feces from infected humans or animals. Crypto is not spread by contact with blood.

Crypto can be spread:
- By putting something in your mouth or accidentally swallowing something that has come into contact with stool of a person or animal infected with Crypto.
- By swallowing recreational water contaminated with Crypto. Recreational water is water in swimming pools, hot tubs, Jacuzzis, fountains, lakes, rivers, springs, ponds, or streams. Recreational water can be contaminated with sewage or feces from humans or animals.
- By swallowing water or beverages contaminated with stool from infected humans or animals.
- By eating uncooked food contaminated with Crypto. Thoroughly wash with uncontaminated water all vegetables and fruits you plan to eat raw. See below for information on making water safe.
- By touching your mouth with contaminated hands. Hands can become contaminated through a variety of activities, such as touching surfaces (e.g., toys, bathroom fixtures, changing tables, diaper pails) that have been contaminated by stool from an infected person, changing diapers, caring for an infected person, and handling an infected cow or calf.
- By exposure to human feces through sexual contact.

What are the symptoms of cryptosporidiosis?
The most common symptom of cryptosporidiosis is watery diarrhea. Other symptoms include:
- Stomach cramps or pain
- Dehydration
- Nausea
- Vomiting
- Fever
- Weight loss

Some people with Crypto will have no symptoms at all. While the small intestine is the site most commonly affected, Crypto infections could possibly affect other areas of the digestive tract or the respiratory tract.

How long after infection do symptoms appear?
Symptoms of cryptosporidiosis generally begin 2 to 10 days (average 7 days) after becoming infected with the parasite.

How long will symptoms last?
In persons with healthy immune systems, symptoms usually last about 1 to 2 weeks. The symptoms may go in cycles in which you may seem to get better for a few days, then feel worse again before the illness ends.

Who is most at risk for cryptosporidiosis?
- People who are most likely to become infected with *Cryptosporidium* include:
- Children who attend day care centers, including diaper-aged children
- Child care workers
- Parents of infected children
- People who take care of other people with cryptosporidiosis
- International travelers
- Backpackers, hikers, and campers who drink unfiltered, untreated water
- People who drink from untreated shallow, unprotected wells
- People, including swimmers, who swallow water from contaminated sources
- People who handle infected cattle
- People exposed to human feces through sexual contact

Contaminated water may include water that has not been boiled or filtered, as well as contaminated recreational water sources (e.g., swimming pools, lakes, rivers, ponds, and streams). Several community-wide outbreaks of cryptosporidiosis have been linked to drinking municipal water or recreational water contaminated with *Cryptosporidium*.

Who is most at risk for getting seriously ill with cryptosporidiosis?
Although Crypto can infect all people, some groups are likely to develop more serious illness.
- Young children and pregnant women may be more susceptible to the dehydration resulting from diarrhea and should drink plenty of fluids while ill.
- If you have a severely weakened immune system, you are at risk for more serious disease. Your symptoms may be more severe and could lead to serious or life-threatening illness. Examples of persons with weakened immune systems include those with AIDS; cancer and transplant patients who are taking certain immunosuppressive drugs; and those with inherited diseases that affect the immune system.

What should I do if I think I may have cryptosporidiosis?
If you suspect that you have cryptosporidiosis, see your health care provider.

How is a cryptosporidiosis diagnosed?
Your health care provider will ask you to submit stool samples to see if you are infected. Because testing for Crypto can be difficult, you may be asked to submit several stool specimens over several days. Tests for Crypto are not routinely done in most laboratories. Therefore, your health care provider should specifically request testing for the parasite.

What is the treatment for cryptosporidiosis?
Nitazoxanide has been FDA-approved for treatment of diarrhea caused by *Cryptosporidium* in people with healthy immune systems and is available by prescription. Consult with your health care provider for more information. Most people who have healthy immune systems will recover without treatment.

Diarrhea can be managed by drinking plenty of fluids to prevent dehydration. Young children and pregnant women may be more susceptible to dehydration. Rapid loss of fluids from diarrhea may be especially life threatening to babies. Therefore, parents should talk to their health care provider about fluid replacement therapy options for infants. Anti-diarrheal medicine may help slow down diarrhea, but a health care provider should be consulted before such medicine is taken.

People who are in poor health or who have weakened immune systems are at higher risk for more severe and more prolonged illness. The effectiveness of nitazoxanide in immunosuppressed individuals is unclear. HIV-positive individuals who suspect they have Crypto should contact their health care provider. For persons with AIDS, anti-retroviral therapy that improves immune status will also decrease or eliminate symptoms of Crypto. However, even if symptoms disappear, cryptosporidiosis is often not curable and the symptoms may return if the immune status worsens.

I have been diagnosed with cryptosporidiosis, should I worry about spreading the infection to others?

Yes, *Cryptosporidium* can be very contagious. Infected individuals should follow these guidelines to avoid spreading the disease to others:

1. Wash your hands frequently with soap and water, especially after using the toilet, after changing diapers, and before eating or preparing food.

2. Do not swim in recreational water (pools, hot tubs, lakes, rivers, oceans, etc.) if you have cryptosporidiosis and for at least 2 weeks after the diarrhea stops. You can pass Crypto in your stool and contaminate water for several weeks after your symptoms have ended. You do not even need to have a fecal accident in the water. Immersion in the water may be enough for contamination to occur. Water contaminated in this manner has resulted in outbreaks of cryptosporidiosis among recreational water users.

Note: You may not be protected in a chlorinated recreational water venue (e.g., swimming pool, water park, splash pad, spray park) because *Cryptosporidium* is chlorine-resistant and can live for days in chlorine-treated water.

3. Avoid sexual practices that might result in oral exposure to stool (e.g., oral-anal contact).

4. Avoid close contact with anyone who has a weakened immune system.

5. Children with diarrhea should be excluded from child care settings until the diarrhea has stopped.

This fact sheet is for information only and is not meant to be used for self-diagnosis or as a substitute for consultation with a health care provider. If you have any questions about the disease described above or think that you may have a parasitic infection, consult a health care provider.

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APPENDIX B: Boil Water Advisory for Public Users of Public Water Supply

Available at: http://www.cdc.gov/crypto/health_professionals/bwa/public.html

During a boil water advisory

General Procedures
Do not serve or consume:
- water that has not been disinfected,
- ice or drinks made with water that has not been disinfected, or
- raw foods rinsed with water that has not been disinfected.

Discontinue service of equipment with water line connections (e.g., water coolers, automatic ice makers, etc.).

Discard ice made prior to the boil water advisory issuance and discontinue making ice. Use commercially-manufactured ice.

Drinking Water
For drinking water, use:
- commercially-bottled water
- and/or water that has been disinfected for *Cryptosporidium* by:
  - boiling at a rolling boil for 1 minute (at altitudes greater than 6,562 feet [>2,000 m], boil water for 3 minutes), or
  - distilling
- and/or water hauled from an approved public water supply in a covered sanitized container
- and/or water from a licensed drinking water hauler truck.

Note: Although chemicals (e.g., bleach) are sometimes used for disinfecting small volumes of drinking water for household use, chemical disinfection is generally not recommended for commercial establishments because of the lack of onsite equipment for testing chemical residuals. Furthermore, *Cryptosporidium* is poorly inactivated by chlorine or iodine disinfection. *Cryptosporidium* can be removed from water by filtering through a reverse osmosis filter, an "absolute one micron" filter, or a filter certified to remove *Cryptosporidium* under NSF International Standard #53 or #58 for either "cyst removal" or "cyst reduction." (see A Guide to Water Filters for more information) However, unlike boiling or distilling, filtering as just described will not eliminate other potential disease-causing microorganisms, such as bacteria and viruses. Ultraviolet light treatment of water is not effective against *Cryptosporidium* at normally-used levels.

Cooking and Food Preparation
For cooking and food preparation:
- Discard any ready-to-eat food prepared with water prior to the discovery of the water contamination.
- Prepare/cook ready-to-eat food using the drinking water alternatives listed above and/or restrict the menu to items that do not require water.

For cooking and food preparation equipment/utensils/tableware:
- Use single service/use articles.
  and/or
  Clean and sanitize equipment/utensils/tableware using the drinking water alternatives listed above. Follow the established procedures to wash, rinse, and sanitize.

- *Cryptosporidium* on equipment/utensils/tableware may be disinfected using dishwashing machines that have a dry cycle or a final rinse that exceeds 113°F for 20 minutes or 122°F for 5 minutes or 162°F for 1 minute.
- Discontinue operations when inventories of clean equipment/utensils/tableware are exhausted.

Handwashing

For handwashing, wet hands with the drinking water alternatives listed above and apply liquid, bar, or powder soap.

- Rub hands together vigorously for 20 seconds, making sure to lather and scrub all surfaces, including backs of hands, wrists, between fingers, and under fingernails.
- Rinse hands well with running water – if running water is not available, water may be poured on the hands by another person.
- Dry hands with paper towels or an air dryer.
- Use the paper towels to turn off the faucet, if applicable.

Note: *Cryptosporidium* is not killed by alcohol gels and hand sanitizers. Soap and disinfected water are specifically recommended for preventing cryptosporidiosis.

When the boil water advisory is cancelled

- Flush pipes and faucets. Run cold water faucets continuously for at least 5 minutes.
- Flush water coolers. Run coolers with direct water connections for 5 minutes.
- Flush home automatic ice makers. Make three batches of ice cubes and discard all three batches.
- Run water softeners through a regeneration cycle.
- Drain and refill hot water heaters set below 113°F.
- Change all point-of-entry and point-of-use water filters, including those associated with equipment that uses water.

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