Cryptosporidiosis in Georgia

A Classroom Case Study

INSTRUCTOR'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.

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- *information necessary to examine confounders (i.e., factors that are associated with both the disease of interest and the exposure of interest that can affect the observed association between the disease and exposure of interest [e.g., sex, age, education, and socioeconomic status]).*

5. *Determine the best technique to collect survey information − Options for collecting survey information include face-to-face interviews, telephone interviews, or self-administered questionnaires. (The later includes Internet surveys, which were unavailable at the time of Carrollton's outbreak.) The means used to collect the necessary information is based on the time available to collect the information, likely costs and resources, characteristics of the target population, and the sensitivity of the information collected.*
6. *Create the questionnaire − Creating the questionnaire includes the exact wording of the questions and potential responses to the questions, the layout of each question, and the sequencing of the questions and skip patterns. Questionnaires (or questions) successfully used in other investigations can be modified for use in the current survey. For example, a generic questionnaire for a case-control study on cryptosporidiosis is available at [http://www.cdc.gov/healthywater/emergency/toolkit/drinking-water-outbreak-toolkit.html.](http://www.cdc.gov/healthywater/emergency/toolkit/drinking-water-outbreak-toolkit.html)*
7. *Create supporting materials − An introduction to the survey is needed and typically includes the purpose of the survey, why the participant was selected, protection of the participant's confidentiality, the sponsor of the survey (i.e., who is funding the survey or who will be using the information), the survey's length, and contact persons). Additionally, consent forms, protocols for collecting clinical specimens, and health communication documents that can be accessed directly by survey participants or used by interviewers to answer participant questions will need to be developed.*
8. *Pilot-test survey materials − Pilot-testing allows identification of problems with the survey instrument before data collection begins. The goal is to determine not only if the questionnaire is user-friendly but also the validity of the information collected and the time necessary to complete the questionnaire. Pilot-testing often occurs in multiple phases. Investigators often start by asking selected accessible persons who were not involved in developing the materials to review them. Investigators might then test the questionnaire with members of the target population and administer the questionnaire as planned for the real survey.*
9. *Apply for human subjects review − Because a community survey involves interactions with human subjects, it will be subject to the human subjects guidelines established by the agency conducting the survey or overseeing its administration. Depending of the circumstances, the study protocol, questionnaire, and related materials might need to be reviewed and approved by an internal review board (often called an institutional review board or IRB) to ensure the wellbeing of survey participants and compliance with ethical standards.*
10. *Train interviewers − To ensure valid and uniform collection of survey information, interviewers should be trained in administration of the survey questionnaire. They should also learn how to answer questions from survey subjects and how to report problems to investigators.*
11. *Implement fieldwork − The primary focus of the fieldwork will be contacting participants and administering the questionnaire. Other field activities include keeping track of which participants have responded and which have not, following up with nonrespondents, monitoring survey execution, and troubleshooting problems as they arise). Designating one person to review all completed questionnaires immediately for problems is strongly advised.*
12. *Review and edit data − If the survey is not administered online, printed copies of questionnaires should be reviewed before they are entered into the computer database for completeness and legibility. Data-entry errors can be minimized by having the data entered into the database twice by two different persons and then comparing both entries. After being entered, a cross-tabulation of the data can be used to identify missing and nonsensical values that then can be corrected. Efforts should be made to identify study participants who do not meet eligibility criteria, excluding ineligible persons from data analyses, and determining definitions for various parameters to be included in the analyses.*

- *Multi-stage sampling − Multi-stage sampling is a complex form of cluster sampling. In the first stage, clusters (i.e., primary sampling units) are identified and a sample of the clusters is selected by using simple random sampling, systematic sampling, or stratified random sampling. In the second stage, units within the clusters (i.e., secondary sampling units) are randomly selected.*

If a population listing is available, simple random sampling and systematic sampling are conceptually easiest to implement. A stratified random sample should be used when the population can be divided into meaningful subsets and estimates for the different subsets are desired. Cluster sampling, including multistage sampling, is good to use when the population of interest is too large, cannot be enumerated, or is distributed widely. For results from a cluster sample to reach the same level of precision as a simple random sample, the sample size must be appreciably greater, which increases the needed resources. Cluster sampling also requires more complex statistical analysis to account for the mode of sampling.

For this outbreak and setting in which a listing of all potential survey subjects is available, simple random sampling (e.g., random-digit-dialing) or systematic sampling (e.g., selecting households from the telephone directory or a county census) are reasonable approaches. The investigator might want to stratify the population according to those who live within the city limits of Carrollton and those who live in Carroll County but outside of the city.

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?

Options for collecting survey information include face-to-face interviews, telephone interviews, or self-administered questionnaires. The methods used to collect the necessary information will be based primarily on the time available to collect the information (i.e., the need for timely information to support necessary public health actions), likely costs and resources, characteristics of the target population, and the sensitivity of the information collected. The following discussion presents the advantages and disadvantages for each method of collecting the information.

Face-to-face interviews
Advantages: Results in higher response rates than telephone or self-administered questionnaires; can use more complex questionnaire designs (with skip patterns); results in more accurate recording of responses and more anecdotal information.
Disadvantages: Requires contacting subjects and arranging meetings; seems less anonymous to subjects than self-administered questionnaires; can result in less honest responses because subjects give answers they think the interviewer wants to hear; has increased potential for interviewer bias; is most costly in terms of time and resources (particularly if subjects are geographically dispersed).

Telephone interviews
Advantages: Is easier to access subjects than face-to-face interviews or self-administered questionnaires; usually results in higher response rates than self-administered questionnaires; can use more complex questionnaire designs (with skip patterns); results in more accurate recording of responses; is less costly than face-to-face interviews.
Disadvantages: Seems less anonymous to subjects than self-administered questionnaires; might result in less honest responses because subjects give answers they think the interviewer wants to hear; has potential for interviewer bias; is more costly than self-administered questionnaires; can result in a more biased sample because of increased screening of calls by homeowners (through answering machines and voicemail) and increased use of cellular phones.

Self-administered questionnaires
Advantages: Seems more anonymous to subjects; can result in more honest responses from subjects; takes less investigator time after questionnaires are received by subjects; is less expensive than face-to-face or telephone interviews.
Disadvantages: Greater care should be taken in developing the questionnaire so that it can be completed easily by the subject; requires additional time for sending questionnaires to subjects and waiting for return of responses; usually results in more errors in recording of responses; results in lower response rate and requires more follow-up to obtain completed surveys.

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 the 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?

- *Inform survey participants of the survey before it occurs or during implementation of the survey, if sufficient time is unavailable before it starts. Survey participants can be notified individually or by a general notification of the community through the local media. Notifying survey participants beforehand allows participants to mentally prepare for the survey and become comfortable with the idea of participating.*
- *Provide potential participants sufficient background information to gain their interest. The subject will be more likely to participate if the topic is of interest or the goal seems worthy.*
- *Inform potential respondents of who is conducting the survey and what credentials they hold. Including a local connection (e.g., using the name of the local health department) often helps.*
- *Provide a telephone number that can be called to verify the authenticity of the survey. Establishing legitimacy can help convince potential respondents to participate in a survey.*
- *Inform potential participants about their rights, their privacy, and that no negative consequences of nonparticipation will result.*
- *Make survey questions clear and concise. If potential respondents have trouble understanding the questions or following the skip patterns, they will be less likely to participate or might not complete the survey.*

- *Keep the questionnaire short. Long questionnaires are less likely to be completed than short ones.*
- *Give careful thought to the ordering of the questions. Ideally, the early questions in a survey should be easy and pleasant to answer. Difficult and sensitive questions should be placed near the end after rapport has been established between the interviewers and the subject.*
- *Offer to answer questions at the end of the survey. The lure of additional information might drive certain participants to complete the entire questionnaire.*
- *Follow up with nonrespondents. Additional attempts should be made to reach nonrespondents. Attempts should occur at different times of the day, different days of the week, and on weekends.*
- *Follow through with analyzing the survey results and reporting them. It will not help with the current survey, but it will build credibility and goodwill for the next time a survey is undertaken.*

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.

Residents of the city of Carrollton were twice as likely as nonresidents to become ill. Persons who were exposed to the public water supply at home, school, or work were 3 times as likely to become ill as those who were not. Both findings were unlikely (i.e., less than 5 chances in 100) to have occurred because of chance alone.

The increased risk for infection among persons residing in Carrollton might reflect the fact that they were more likely to be exposed to the public water supply through their homes than people living in the county but outside of Carrollton city limits.

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.

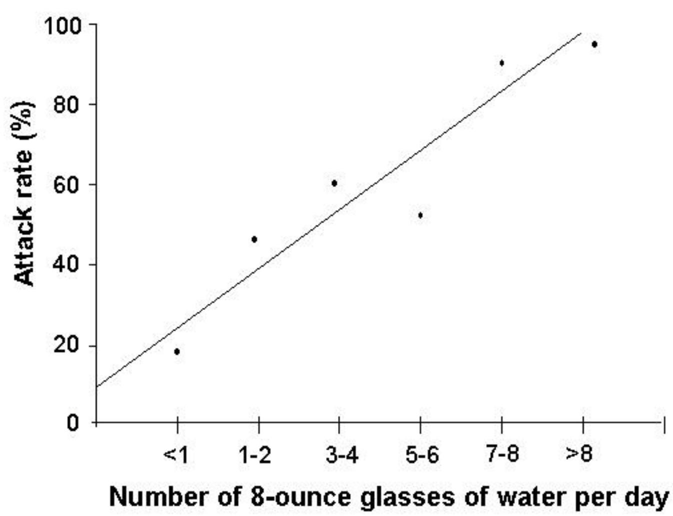
Average number of 8-ounce glasses of water consumed/day	Number ill	Number exposed	Attack rate
<1	2	11	18%
1−2	17	38	45%
3−4	28	48	58%
5−6	15	31	48%
7−8	21	25	84%
>8	26	29	90%
Total	109	182	60%

*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

Interpretation: As the average number of glasses of water consumed each day increased, the attack rate also increased. This dose-response finding supports the conclusion that the water was the source of the outbreak.

Figure A. 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. (INSTRUCTOR VERSION ONLY)



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?

If the public water supply was the source of the outbreak, multiple possible explanations exist for illness among persons with no reported exposure to the water at home, school, or work

- *The illness was caused by something other than cryptosporidiosis. Abdominal pain and diarrhea are not specific for cryptosporidiosis alone.*
- *Ill persons were exposed to public water at places other than at home, school, or work (e.g., homes of friends or family, grocery stores, or restaurants) and forgot to mention these exposures in responding to the questionnaire or during the interview.*
- *The persons were exposed through secondary spread of illness from someone who had been exposed to the public water supply. Examination of the epidemic curve for the outbreak might indicate the role of secondary spread. A slow return in the number of cases to baseline is evidence of secondary spread of infection.*
- *Other sources of cryptosporidiosis existed in the community (e.g., cattle).*
- *The source of the outbreak was not the public water supply.*

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?

Note: *The quality of treated water is affected by multiple variables that interact in a complex manner. Therefore, the investigation team should include persons who have extensive knowledge of water treatment methods and plant engineering (e.g., environmental health specialists, utility engineers).*

Activities
Because every water treatment plant differs, the activities included in the evaluation of any particular plant will also vary (and can vary depending on current plant conditions). Investigators often undertake the following activities in the evaluation of water treatment plants:

Determine the quality of raw water

- *Collect information on the source of the water for the plant and means in place to protect the source from contamination.*
- *View maps of the watershed and tour the area.*
- *Collect information on conditions likely to affect the quality of the water from that source (e.g., construction, flooding, spring run-off, presence of farm animals or wildlife, waste water outflows at the water treatment plant).*
- *Inspect the wellhead (ground water) or intake point (surface water).*

Describe the water treatment process

- *Review blueprints and diagrams of the plant.*
- *Tour the plant.*
- *Collect detailed information on procedures used to treat water, including chemicals added and dosages, techniques for adding and mixing chemicals, order of addition of chemicals, settling time, contact time, and type of filtration.*
- *Observe procedures used to treat water.*
- *Collect information about recent changes in water treatment procedures.*
- *Inspect equipment used in water treatment (e.g., chlorine feeding equipment, sedimentation tanks, and filters) and collect information on maintenance or breakdown of equipment.*
- *Collect information on plant hydraulics and determine water flow rates and flow patterns.*
- *Inspect equipment used to monitor flow rates or chemical treatment processes.*

Determine the effectiveness of the water treatment process

- *Collect untreated (raw) and treated water specimens for testing for total coliforms, fecal indicators (e.g., E. coli), turbidity, and possibly the causative agent.*
- *Ascertain routine testing procedures used to determine quality of water, including frequency, timing, and how recorded and quality-control testing.*
- *Review routine test results for period of interest (e.g., residual disinfectant, pH, and turbidity).*
- *Measure temperature and pH of raw water.*
- *Measure disinfectant residual of treated water.*
- *Calculate contact time (i.e., period between introduction of disinfectant and when water is used).*
- *Collect historical samples of treated water (e.g., water bottles, ice, and filters in refrigerators; toilet tanks in houses where residents have been away; storage tanks; taps at seldom-used and dead-end locations; and ice from commercial ice plants).*

Determine the integrity of the water distribution system

- *Inspect holding tanks.*
- *Collect samples from holding tanks and test for chlorine residual and total coliforms or indicators of fecal contamination.*
- *Examine water distribution maps.*
- *Collect samples from taps and test for chlorine residual and total coliforms or indicators of fecal contamination.*
- *Collect information on unusual events that might negatively affect the water system (e.g., damage to pipes in distribution system, pump failures, draining distribution reservoirs, or massive pumping to fight fires that can produce low pressures and resultant contamination through cross-connections or back-siphonage [i.e., reversal of normal flow in a water distribution system caused by negative pressure in the supply pipe]).*

Persons who should be consulted

- *Water treatment plant superintendent and operators*
- *Maintenance technicians*
- *Laboratorians who oversee water-quality tests*
- *Engineers who designed water treatment plant*
- *Engineers or state agency employees who approved water treatment plant design*
- *Consulting engineers knowledgeable of water treatment facilities, water system hydraulics, or other specialty area*
- *Governmental regulators who oversee the water utility's compliance with drinking water regulations*

Records and data sources of interest

- *Results of routine water-quality tests (e.g., total coliform counts, fecal indicators, if any, turbidity, and total and residual chlorine) of both untreated and treated water and monitoring triggers*
- *Records of water treatment procedures (e.g., logs of chemicals used and dosages)*
- *Logs of system maintenance and repairs at the plant or to the water distribution system*
- *Water customers' complaint log*
- *Records of damage or repairs in and around water distribution system (e.g., water main breaks, sewer system maintenance, and road repairs)*
- *Weather reports that might reflect conditions for increased contamination of surface water supplies (e.g., flooding, low temperatures, and spring runoff)*

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*?

Given the resistance of Cryptosporidium oocysts to chlorination, adequate filtration of water is the most effective treatment measure. Filtration techniques should remove particles greater than 1 µm in diameter to be effective. Special attention should be given to the condition of the filters, rate of flow of water through the filters, and filter maintenance (e.g., means used to clean and restart filters that have been offline and allowing the filter to ripen before being used [i.e., allowing the sand particles to develop a thin film of active microorganisms that increase the filter's effectiveness at removing particles less than 100 µm in diameter]).

Improvements in the flocculation and sedimentation will improve the effectiveness of filtration by increasing the floc size and removing large particles before filtration. Replacement of the mechanical agitators will help in this regard.

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?

The following can help with monitoring the effectiveness of the control measures:

- *Water monitoring*
- *Intermittent inspections of water treatment equipment (to see if properly installed and working)*
- *Monitoring the turbidity of treated water*
- *Testing treated water for Cryptosporidium oocysts*

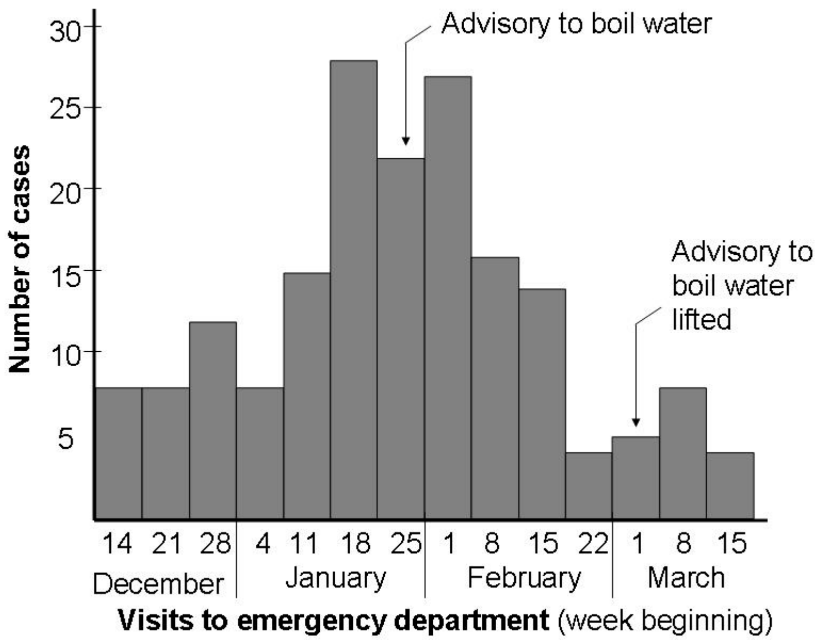
Surveillance for disease

- *Human cases of cryptosporidiosis*
- *Visits for diarrhea or abdominal pain to the local hospital emergency department*
- *Visits for diarrhea or abdominal pain to the college infirmary*

Physicians should be taught about the signs and symptoms usually associated with cryptosporidiosis and the need to request special testing to detect Cryptosporidium oocysts in stool specimens. Laboratories should be alerted to report increased requests for stool cultures or examinations and to report laboratory-confirmed cases of cryptosporidiosis.

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]

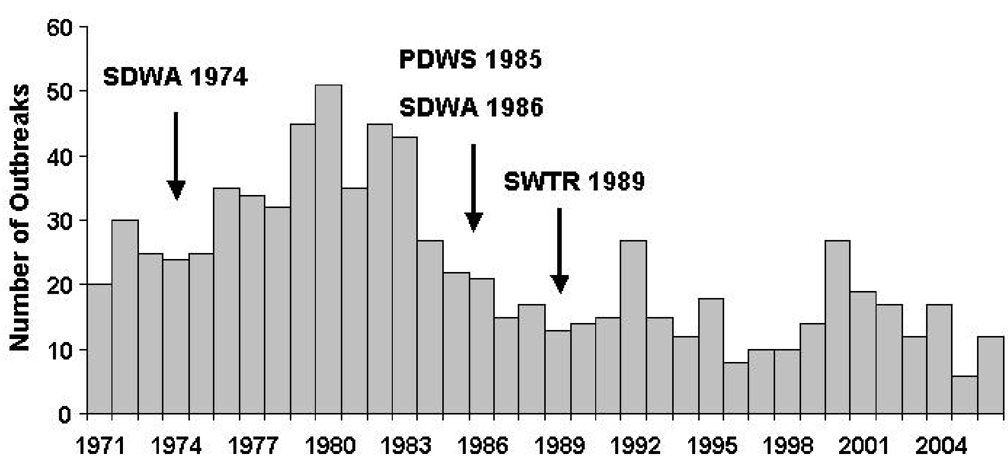
Before the Carrollton outbreak, *Cryptosporidium* had been linked only with waterborne outbreaks in communities using unfiltered surface water for drinking. The outbreak in Carrollton was the first reported contamination of a filtered surface water system. Although the sand filtration and chlorination 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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Content source: Division of Parasitic Diseases, National Center for Zoonotic, Vector-Borne, and Enteric Diseases

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:*
    - o boiling at a rolling boil for 1 minute (at altitudes greater than 6,562 feet [>2,000 m], boil water for 3 minutes), or
    - o 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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