

Disease Detectives Division C Event

Part B: Fun at the Child Care Center

2014 National Science Olympiad Tournament

University of Central Florida

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This scenario presented in this Disease Detectives event is hypothetical. To the best of our knowledge, there was no outbreak of asthma in Orlando during spring of 2012. It is adapted from a case-study (given as a reference) based on an actual outbreak in Barcelona, Spain. The event was developed by CDC subject matter expert:

Ralph Cordell, Ph.D.

Epidemiologist

Division of Scientific Education and Professional Development
Center for Surveillance, Epidemiology, and Laboratory Services

Scientific and editorial review was provided by Ralph Cordell, Ph.D. and Kelly Cordeira, M.P.H. from Career Paths to Public Health, Division of Scientific Education and Professional Development, Center for Surveillance, Epidemiology, and Laboratory Services, Office of Public Health Scientific Services.

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Contact Information

Please send questions and comments to scienceambassador@cdc.gov.

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2014 Division B

Part B: Fun at the Child Care Center

It is a warm Monday morning in mid-September. You are the chief epidemiologist at a large city health department. As you review reports electronically transmitted to your office during the weekend, the phone rings. The caller is Beth Grey, director of Child Care Facility A, a child care center in your jurisdiction. Beth says she received a call from the parents of a young boy who was hospitalized during the weekend with severe diarrhea and dehydration. She says her staff has noticed a slight increase in the number of children with loose stools during the last few weeks. The staff was not too concerned because the stools were not bloody, and pediatricians were telling parents the diarrhea was because of teething, food allergies, or antibiotic use.

1. **(1 point) Which of the following represents a key component of the definition of an outbreak? (circle best answer)**
 - a. **The outbreak happens suddenly.**
 - b. **The outbreak involves a lot of people.**
 - c. **Certain persons are hospitalized or die.**
 - d. **More cases than expected are reported.**
 - e. **The outbreak is caused by an infectious agent.**
 - f. **The outbreak is widespread.**

2. **(2 points) Give one more piece of information you need to determine if this is an outbreak.**

You ask Beth for the child's name and age, hospital where he was admitted, his pediatrician's name, whether she knows of any laboratory results, and the last date the boy attended the center. Beth tells you the child is 3 years old and is at Children's Hospital under the care of Dr. Brown. She replies that she does not know what kind of tests were done. The boy last attended the child care center on the previous Thursday and was well that day. You have worked with Dr. Brown and know him to be an excellent physician who understands public health as well as clinical medicine. However, you are concerned about the recent increase in children with diarrhea at Child Care Facility A and need more information before you can develop a hypothesis.

3. **(1 point) Which of the following is the most important question you would ask about the children with diarrhea to understand place? (circle best answer)**
 - a. **Where do they live?**
 - b. **What classroom is each child in?**
 - c. **Have they traveled out of the area?**
 - d. **What other exposures did they have in the week before they became ill?**

4. **(1 point) Which of the following is the most important question you would ask about the children with diarrhea to address time? (circle best answer)**
 - a. **When was the last day they were at the center?**
 - b. **What time of day did they become ill?**
 - c. **When did they first attend the center?**
 - d. **What day did they become ill?**

You tell Beth that you have to get ready for a meeting. Before you end the call, you ask Beth to provide information concerning the number of children with diarrhea at the child care center for the previous 8 weeks of this year and the same time period last year. For each week, you need the number of children with diarrhea and the number who attended at least one day during that week. Beth says she will have someone get right on it and send the information to you in a spreadsheet by e-mail. When your meeting is over, you check your e-mail and find Table 1 from Beth.

Table 1: Number of Children with Diarrhea* and Number of Children Present** at Child Care Facility A, by Weeks 29–36, 2012 and 2013***

	Week 29	Week 30	Week 31	Week 32	Week 33	Week 34	Week 35	Week 36	Total
	2012								
No. with Diarrhea	1	0	3	2	0	4	1	2	13
No. Present	134	143	138	132	139	141	137	136	1100
	2013								
No. with Diarrhea	2	1	3	1	1	3	7	14	32
No. Present	142	139	137	141	143	138	144	140	1124

* Includes those recorded by child care providers and reported by parents during daily health checks.

** A child was considered present if he or she attended at least one whole day during the week.

*** Health department was notified at start of week 37.

5. (3 points) Calculate incidence of diarrhea per child-year for weeks 29–36 during 2013.

6. (2 points) Calculate the relative risk for diarrhea during 2013, compared with 2012.

7. (1 point) Which of the following statistical tests would you use to determine the statistical significance of the difference in rates? (circle best answer)

- a. T-test
- b. Fisher’s exact test
- c. Paired T-test
- d. Chi square statistic

You review the data in Table 1, call Dr. Brown’s office, and ask his nurse about the boy admitted to Children’s Hospital. She says the child was admitted for acute dehydration resulting from watery diarrhea and vomiting. He responded well to treatment and was sent home a few hours ago. A stool sample was collected when the child was admitted Sunday and test results should be available within a day or so. The initial diagnosis was viral diarrhea or possible cryptosporidiosis—definitely not related to teething or antibiotics. You thank her for the information. You ask whether the hospital lab can speed up the testing and call you as soon as they get results. The nurse says she will do her best.

You call Beth to tell her that on the basis of the information she sent, a problem might have developed. She says they have had a terrible day so far. One of her teachers went home ill and at least three more children developed diarrhea. In one of the 4-year-old classrooms, a child had feces running down her leg. She says one child had the

same symptoms the week before last, got better, and is sick again. You tell her that you spoke with Dr. Brown's office and it appears a communicable disease outbreak at the center might be occurring, and you will put together a team to visit this afternoon. You ask Beth to break down the data she sent by classroom and create a table showing the number of children with diarrhea and number of child-weeks of attendance for each classroom 8-week period. You explain to her how to calculate child-weeks of attendance.

8. (2 points) Which part of the descriptive epidemiology triad are you addressing by looking at the data by classroom?

You contact the Environmental Health and Nursing units of the health department, explain the situation, and ask them to assign a sanitarian and public health nurse to accompany you on a field visit. You next contact the local office of the child care licensing agency that to let them know what is going on and what you plan to do, and invite them to send a representative along on the field visit. Finally, you call your colleague Larry Johnson at the state laboratory and talk with him about the situation. "You know, Brown may well be right on this one," Larry says. "Several types of viruses cause watery diarrhea. Rotaviruses and noroviruses are the most common. A vaccine is available for rotavirus, and norovirus outbreaks tend to be really explosive. This outbreak seems a bit like a slow burner. That kid who was sick, got well, and then is sick again sure sounds like a recrudescence case. We see that a lot with Crypto.¹ Why don't you stop by and pick up some stool collection kits? We can test for that here."

9. (4 points) List two steps of an outbreak investigation that were addressed in the previous paragraph.

You tell your secretary you will probably be at Child Care Facility A all afternoon. You meet Bill Rosales, the sanitarian, and Marge Kunith, the public health nurse, in the parking lot and give them the address. You tell them a colleague at the state laboratory thinks this might be a cryptosporidiosis (Crypto) outbreak and you are going to pick up some stool collection kits. You tell Bill that, in addition to his regular inspection routine, you want him to check for any water-related play activities, such as wading pools or water tables, the center might offer during the summer. You tell Marge to give special attention to child care practices in the rooms where they are diapering children and to disinfection practices.

Children using diapers are at greater risk for diarrhea than those who are toilet trained, because they explore their environment and put things into their mouths more often than older children. The majority of children are toilet trained by age 3 years. Outbreaks of diarrheal illness are less common among toilet-trained children and often involve common exposure.

10. (2 point) What is the American Public Health Association recognized mode of transmission for most diarrheal diseases? (Note: fecal-oral is not among the APHA recognized modes of transmission)

¹ "Crypto" refers to *Cryptosporidium sp.*

You pull into the parking lot at Child Care Facility A, a large facility in what was once an elementary school. You see a group of children playing with a water table and hose on the playground. Traffic was bad and you stopped by the laboratory to pick up stool kits, so you are not surprised that Bill and Marge are already inside. You introduce yourself to the receptionist and show her your identification badge. “Your colleagues are already going about their business,” she says. “I’ll page Ms. Grey. Have a seat.” You look around as you wait. The halls are clean, but with is a faint odor of chlorine. Children’s art work, including drawings of handwashing and toothbrushing, are displayed on the walls. A bulletin board has announcements of activities and a large poster telling parents not to bring their children if they exhibit a list of symptoms.

Beth soon greets you. “Hi, I’m Beth Grey, the Director. You must be the person I spoke to on the phone. Thanks for coming. Your colleagues are already checking the place out.” You explain that you would like to talk with her to find out a little bit about the facility and the situation. She shows you to a small conference room just off the main entrance.

She takes a seat and begins. “We’ve been here for almost seven years. We have 30 staff and a licensed capacity of 125 children. They don’t all come every day and we have about 150 enrolled right now. That includes our after-school kids. We don’t accept infants. We divide our kids up by age, 1-year-old, 2-years-old, 3-years-old, 4-years-old, and then the 5-years-old. We have two classrooms for each. We call them A and B and name them by the ages of the kids. Classroom 1A is one of the classrooms for our 1-year old kids. Classroom 1B is the other. Our kids move up to the next class on their birthdays. Our normal hours are 7:30 a.m. to 5:30 p.m., but we have an early morning drop-off starting at 6:30 a.m. and a late-day group that ends at 6:30 p.m. We follow the American Academy of Pediatrics recommendations for when kids should be kept home. We check our kids every morning when they arrive. Our parents tell us when their kids are sick.”

Beth slides a piece of paper across the table toward you. “I had our receptionist reorganize the information you wanted,” she says. Just then the receptionist comes to the door. “Ms. Grey, there is a call for you from Mrs. Brownlee. She heard about an “epidemic” and wants to know more about it,” she says. Beth leaves to take the call. You look at the information on the paper (Table 2) and compare the age distribution of children with diarrhea during the last 2 years.

Table 2: Number of Children with Diarrhea* and Number of Children Present** by Age Classroom for Weeks 29–36, 2012 and 2013

Classroom	Year			
	2012		2013	
	No. Ill	Child-weeks	No. Ill	Child-weeks
1A	3	99	3	107
1B	2	89	5	91
2A	1	89	8	94
2B	2	73	4	70
3A	1	105	3	110
3B	2	109	4	111
4A	1	110	2	114
4B	0	134	3	136
5A	1	151	0	153
5B	0	141	0	138

* Includes illness reported by parents and observed by care givers.

** A child was counted as being present if he or she attended one whole day that week.

11. (2 points) Which of the classrooms in Table 2 include children who are not toilet trained (assume all 3-year-olds are toilet trained)?

12. (2 points) If the age distribution of the children at Child Care Facility A changed substantially from 2012 to 2013, what technique would you need to use to compare the overall illness rates?

13. (16 points [2 points] each) Complete the following table. Show your calculations and express rates as units

	2012	2013	Relative Risk (2013 vs. 2012)
Diapered (Incidence Rate)	A	B	C
Toilet-trained (Incidence Rate)	D	E	F
Relative Risk: Diapered vs. Toilet-trained	G	H	

- A.
- B.
- C.
- D.
- E.
- F.
- G.
- H.

14. (2 points) Which of the following statements are supported by the information in Table 2 and your calculations? (circle all that apply)

- a. Diapered children had greater risk for diarrheal illness than toilet-trained children during both periods.
- b. Both groups experienced greater risk for diarrheal illness during 2012 than 2013.
- c. The excess risk among diapered children, compared with toilet-trained children was significantly greater during 2013 than 2012.
- d. Data support a hypothesis that the increase in diarrheal illness during 2013 involved both diapered and toilet-trained children.

Beth returns a few minutes later. She tells you that Bill and Marge are nearly finished with their inspection. You tell her you saw some interesting things in the information she provided. "I've spoken with the folks at the lab and we think this might be caused by a parasite called *Cryptosporidium*, commonly called Crypto." About that time your cell phone buzzes. Your secretary is calling so you answer. "The lab just called," she says. "They were able to speed up testing and the stool from the day care child was positive for Crypto." You thank her and turn to Beth. "I think this problem might be Crypto," you say. "I have some stool containers and parent permission forms in the car. I've only got a dozen right now but I think it would be a good idea if we could collect some stool specimens from some of your kids and get them tested for Crypto." "Sure, we can set that up," Beth says. "Who do you want to test?"

- 16. (1 point) You have 12 stool test kits available and need to decide which children to test. Which of the following screening schemes would be the best to use if you wanted to test the hypothesis that, throughout the center, those with diarrhea have *Cryptosporidium* and those without diarrhea do not? (circle best answer)**
- Select classrooms with the most ill children and test only those with a recent history of diarrhea.**
 - Test only children with a recent history of diarrhea, but select only one or two from each classroom.**
 - Select one or two classrooms and test a few children with a recent history of diarrhea and a group of children who have not had diarrhea (controls).**
 - Test a randomly selected group of children with a recent history of diarrhea and a randomly selected group of children without a recent history of diarrhea.**
- 17. (1 point) Which of the following screening schemes would you use if you wanted to determine the prevalence of infection among a group of students? (circle best answer)**
- Select classrooms with the most ill children and test only those with a recent history of diarrhea.**
 - Test only children with a recent history of diarrhea, but select only one or two from each classroom.**
 - Select one or two classrooms and test a few children with a recent history of diarrhea and a group of children who have not had diarrhea (controls).**
 - Select the classroom with the most ill children and test everyone, even if they do not have a recent history of diarrhea.**

You know that noninfectious diarrhea is a fairly common occurrence in young children and decide to test ten children with a recent history of diarrhea from different classrooms and two children who have not had diarrhea.

Bill and Marge come into the room as you finish explaining your testing plan to Beth. You ask her to leave the room so you can hear their reports in private. “Okay, it looks like we have a Crypto outbreak here,” you say. “At least the boy who was hospitalized this last weekend tested positive. What did you find?”

Marge speaks first. “Well the children in the 1-year-old rooms were having their nap time so I did not get to see much. I spent most of my time in the 2-year old rooms. They have two rooms for each age group and use dividers to break the rooms up into smaller areas. The second was a real zoo. One of the children had an ‘accident.’ Feces were running down the poor kid’s leg and the others were all screaming ‘pooeey,’ ‘stinkkeee,’ stuff like that at him. Fortunately, he was on a tiled surface and the aides followed the accepted protocol while cleaning up the mess. I was a bit concerned to see one of the aides wash the child’s backside off in the sink before diapering him.”

Marge continues. “The setup was pretty much the same with the 3-year-olds. They have a child-sized toilet in the corner and a little handwashing sink. The sink had a bunch of toys in it that were going to be washed in the dishwasher. They were serving snacks in one of the rooms and the children were helping pass out cookies. I asked about hand-washing and the teachers told me that the servers were very careful and all used hand sanitizer.”

- 18. (4 points) List four of Marge’s observations that could have contributed to this outbreak.**

Then Bill reports. “I checked the food service area. All meals are prepared offsite and delivered as individual servings to the center daily. They are refrigerated until just before lunchtime, heated in a convection oven, and brought to the classroom where they are served. Drinks are individual sealed servings, you know, the type where you use a straw to punch a hole in a seal. The utensils and serving units are all disposable so there is very little dishwashing needed. The receptionist does all the food preparation and heating. She says she never changes diapers at the center. The refrigeration was working fine. The kitchen area was pretty clean, although I did tell them they needed to change the fly strip, because it was getting crowded. All chemicals and cleaning materials were stored correctly. I really did not find much to cause concern.”

Bill continues. “The playground was in good shape. Equipment was all in good repair and more than the required amount of shock-absorbent material under the swings and climbing equipment was available. The sandboxes all had covers to keep the neighborhood cats out and they looked like they were in good repair. I did not see any wading pools, but there were a couple water tables.² One was being used when I was there. I asked about handwashing. The teacher told me the children all used hand sanitizer before water play. I did see a couple of children drinking the water. The teacher told me that the water tables are emptied and cleaned out at the end of the day or when the water gets dirty. They hose the tables out, turn them upside down, and let them air dry. The toys used in the water tables are just allowed to air dry.”

19. (3 points) List three of Bill’s observations that are cause for concern in regard to this outbreak.

You tell Bill and Marge that you want to screen some of the children for Crypto. You discuss recommendations with them, making sure they agree and that you have covered all points. Marge points out that the facility currently allows children with diarrhea to attend as long as their diapers can contain the stool. After feces have leaked out, it is too late to do much other than clean up the mess. She suggests you recommend changes to the center’s attendance policy.

In making recommendations concerning the prevention and control of illness, disease detectives want to make sure recommendations are both effective and reasonable. For example, closing the facility would certainly stop further transmission, but would pose undue hardship on both the staff and families. Parents might place their infected children in other programs and spread the problem further

² Water tables are wood or plastic tables with raised 4–6-inch edges. They are filled with water or sand and young children play in them with boats, cups, and other toys. Although children can splash and pour water on each other, usually only their hands and arms get into the water.

- 20. (3 points) Which of the below recommendations would you make concerning this outbreak? (circle all that apply)**
- a. Exclude all children with diarrhea until their diarrhea is resolved.**
 - b. Screen all children and staff and allow only noninfected persons to enter the facility.**
 - c. Screen all children, staff, and household contacts and exclude all persons who were infected or were household contacts of infected persons until they were no longer infected whether they had diarrhea or not.**
 - d. Implement a program of daily disinfection of floors, walls, ceilings, and other environmental surfaces throughout the building.**
 - e. Instruct the staff in proper handwashing, diapering, and other hygiene activities and monitor their performance.**
 - f. Exclude children with diarrhea from using water tables.**
 - g. Install hand sanitizer dispensers throughout the facility and encourage both children and staff to use them rather than washing their hands.**

After you talk with Bill and Marge, you call Beth into the room and discuss your recommendations with her. You write them down and ask to have them photocopied so you can leave a set with her. You arrange to pick up the stool specimens in 2 days, agree to stay in touch, and leave to go back to your office.

Late Wednesday afternoon, you get a call from Larry at the state laboratory. He received the stool specimens from Child Care Facility A and should have results for you by the close of business on Thursday. He points out that the test they use has a sensitivity of only 75% for single-stool specimens and that you might want to consider getting multiple specimens from each child. You tell him you will consider that option and get back to him.

- 21. (4 points) The sensitivity of the laboratory test for Crypto is 75%, the specificity is 100%, and the true prevalence of infection is 20%. If you screen 100 children, how many infections will you miss? (Show your calculations.)**

- 22. (4 points) If you were to screen each child twice and consider a child to be infected if either specimen is positive, what would be the sensitivity of the test? (Show your calculations.)**

You call Beth at Child Care Facility A before you leave for the day and ask her how things are going. She says multiple episodes of diarrhea in various classes throughout the facility have been reported, but the majority were among children who were ill before. However, three children had diarrhea for the first time. Two are in the 3-year-old group and one is in the 4-year-old group. The latter has a brother in the toddler class who was ill last week. You tell her you should have results back on Thursday and you will visit Friday morning to discuss follow-up activities.

At midafternoon on Thursday, one of your staff stops by your office to tell you that the laboratory put a rush on testing your specimens and the results are ready. She combined the laboratory results with other information from the children who were tested into a single table that she gives you to review (Table 3). She tells you the laboratory has already contacted the pediatricians of each child tested. They will notify the parents of children who were tested and give them the results. Confidentiality laws do not allow you to give this information directly to Beth, but the parents were told they need to tell her about the results. After that is done, you can discuss the situation with her.

Table 3: Results of Initial Screening for *Cryptosporidium* at Child Care Facility A

Result	Classroom	Week Onset	Symptomatic
Positive	1A	35	Yes
Positive	1A	36	Yes
Positive	2A	36	Yes
Positive	3A	35	Yes
Positive	3A	36	Yes
Positive	4B	36	Yes
Negative	1B	36	Yes
Negative	2A	35	Yes
Negative	2B	36	Yes
Negative	4B	35	Yes
Negative	1A	NA	No
Negative	1A	NA	No

23. (2 points) Give two explanations for the four negative test results from children with symptoms.

24. (4 points) Now that you have a good idea about the agent responsible for this outbreak, write a case definition that you can use for the remainder of the investigation.

You finish reviewing the results and call Beth. She says that several parents have already contacted her about the children's results. She is really concerned because they have had more children and staff with diarrhea during the last week than in any previous week. The majority of classrooms have had at least one ill child. Certain parents told Beth they were thinking of moving their children to another child care program because they are concerned that the problem is growing and everybody might eventually be infected. You ask Beth to send you the names and classrooms of the additional children with diarrhea and discuss a second round of testing with her. You also call Larry to thank him for expediting the results. You discuss the possibility of testing all the children and staff who have not been screened previously and send him a copy of the table by e-mail. Larry says the laboratory can handle the specimen load for testing everyone in the center but it will take a day or so to get material together.

On Friday afternoon you call Beth and ask how things are going at the center. She sounds a bit dejected and she tells you they have done everything you recommended, but are winding up the week with more children with diarrhea than they had the week before, not to mention that children who they thought had recovered are getting diarrhea again. You explain to her that it can take a week or more for symptoms to develop after a person has been infected with *Cryptosporidium* and many of the newly ill people were probably infected before the control measures were put in place. You explain that recrudescence, or recurrent bouts of diarrhea, is common with Crypto and that the best way to prevent additional cases is to adhere to the guidelines for preventing spread of infection. You tell her you will come by Monday to set up testing for all children and staff.

First thing Monday morning you pick up the supplies needed to test everyone at Child Care Facility A. When you arrive at the facility to drop off the supplies, you notice that the facility seems different than it did a week ago, including fewer children and less of a bleach odor. The water tables are gone from the playground and the wastebasket next to the sink in one of the classrooms is full of used paper towels. When you mention these observations to Beth, she says they are not using as much bleach and have switched to disinfecting with peroxide until the outbreak ends. Staff also stopped using hand sanitizer and is having the children wash their hands with soap and water when they arrive in the morning. She says they were going to follow your recommendations about cleaning the water tables, but were concerned that children who were infected and did not have diarrhea would contaminate them. "The weather is getting cooler anyway and we thought it best to just put them up," she says.

Beth and another staff person help you unload the test supplies from your car. You go over the instructions and make sure staff knows what to tell parents. After you review plans for picking up the samples, getting them to the laboratory, and managing additional cases, you head off for a meeting with the infection control practitioners in your area.

On Friday you call Beth. She says sample collection is going well and they have had substantially fewer children getting diarrhea during the past week than the week before. Recurrence is still a problem, but the situation seems improved. You make it clear that the reduction is attributable to their improved hygiene practices, not to screening.

Approximately 2 months have passed and you are piecing together the data from the Child Care Facility A outbreak. You compare the results of the facilitywide testing with reports of watery diarrhea among children and staff (Table 4).

Table 4: Results of Facilitywide Screening (Test 2) for *Cryptosporidium* Among Children and Staff Who Were Symptomatic (Reported Watery Diarrhea) or Asymptomatic

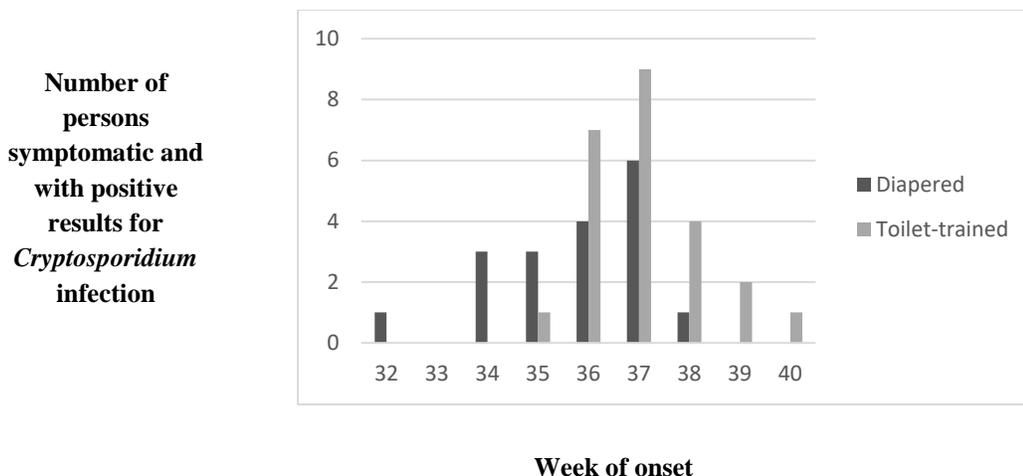
Symptomatic	Screening Results	
	Positive	Negative
Yes	41	12
No	10	120
Total	51	132

25. (2 points) What was the attack rate of laboratory-confirmed *Cryptosporidium* infection among children and staff at Child Care Facility A during weeks 32–40? (Show your calculations.)

26. (4 points) Using the laboratory test as the ultimate standard for identifying persons with *Cryptosporidium* infections, what is the specificity of using watery diarrhea as an indicator? (Show your calculations.)

You create a histogram showing the number persons who were both symptomatic and whose stool test results were positive for *Cryptosporidium* infection in diapered and toilet-trained classes (Figure 1).

Figure 1: Number of Persons with Symptoms and Positive Results for *Cryptosporidium* Infection in Diapered and Toilet-Trained Classrooms, by Week of Symptom Onset



- 27. (2 points) What does the data in Figure 1 indicate about where the outbreak started and where it ended?**
- 28. (3 points) On the basis of what you have been told about practices and conditions in this child care facility, list three ways that *Cryptosporidium* infection might have spread from one of the above groups to the other.**
- 29. (2 points) How can you explain the fact that your prevention measures were started at the beginning of week 37 yet the greatest number of cases among both diapered and toilet-trained persons occurred during that week (i.e., were your measures effective or not)?**
- 30. (6 points) List three broad recommendations you would make for all child care programs in your area to prevent this sort of outbreak from happening again.**

Part B: Fun at the Child Care Center

(KEY)

It is a warm Monday morning in mid-September. You are the chief epidemiologist at a large city health department. As you review reports electronically transmitted to your office during the weekend, the phone rings. The caller is Beth Grey, director of Child Care Facility A, a child care center in your jurisdiction. Beth says she received a call from the parents of a young boy who was hospitalized during the weekend with severe diarrhea and dehydration. She says her staff has noticed a slight increase in the number of children with loose stools during the last few weeks. The staff was not too concerned because the stools were not bloody, and pediatricians were telling parents the diarrhea was because of teething, food allergies, or antibiotic use.

15. (1 point) Which of the following represents a key component of the definition of an outbreak? (circle best answer)

- a. The outbreak happens suddenly.
- b. The outbreak involves a lot of people.
- c. Certain persons are hospitalized or die.
- d. *(Answer) More cases than expected are reported.*
- e. The outbreak is caused by an infectious agent.
- f. The outbreak is widespread.

16. (2 points) Give one more piece of information you need to determine if this is an outbreak.

(Answer) Expected or baseline number of cases of diarrhea.

You ask Beth for the child's name and age, hospital where he was admitted, his pediatrician's name, whether she knows of any laboratory results, and the last date the boy attended the center. Beth tells you the child is 3 years old and is at Children's Hospital under the care of Dr. Brown. She replies that she does not know what kind of tests were done. The boy last attended the child care center on the previous Thursday and was well that day. You have worked with Dr. Brown and know him to be an excellent physician who understands public health as well as clinical medicine. However, you are concerned about the recent increase in children with diarrhea at Child Care Facility A and need more information before you can develop a hypothesis.

17. (1 point) Which of the following is the most important question you would ask about the children with diarrhea to understand place? (circle best answer)

- a. Where do they live?
- b. *(Answer) What classroom is each child in?)*
- c. Have they traveled out of the area?
- d. What other exposures did they have in the week before they became ill?

18. (1 point) Which of the following is the most important question you would ask about the children with diarrhea to address time? (circle best answer)

- a. When was the last day they were at the center?
- b. What time of day did they become ill?
- c. When did they first attend the center?
- d. *(Answer) What day did they become ill?*

You tell Beth that you have to get ready for a meeting. Before you end the call, you ask Beth to provide information concerning the number of children with diarrhea at the child care center for the previous 8 weeks of this year and the same time period last year. For each week, you need the number of children with diarrhea and the number who attended at least one day during that week. Beth says she will have someone get right on it and send the information to you in a spreadsheet by e-mail. When your meeting is over, you check your e-mail and find Table 1 from Beth.

Table 1: Number of Children with Diarrhea* and Number of Children Present** at Child Care Facility A, by Weeks 29–36, 2012 and 2013***

	Week 29	Week 30	Week 31	Week 32	Week 33	Week 34	Week 35	Week 36	Total
	2012								
No. with Diarrhea	1	0	3	2	0	4	1	2	13
No. Present	134	143	138	132	139	141	137	136	1100
	2013								
No. with Diarrhea	2	1	3	1	1	3	7	14	32
No. Present	142	139	137	141	143	138	144	140	1124

* Includes those recorded by child care providers and reported by parents during daily health checks.

** A child was considered present if he or she attended at least one whole day during the week.

*** Health department was notified at start of week 37.

19. (3 points) Calculate incidence of diarrhea per child-year for weeks 29–36 during 2013.

(Answer) Incidence₂₀₁₃ = (32 cases × 52 weeks/year) ÷ 1124 child-weeks = 1.48 cases per child-year (3 points)

(Scoring guidance: 1 point for correct numerator, 1 point for correct denominator, 1 point for adjusting week data to year.)

20. (2 points) Determine the relative risk for diarrhea during 2013, compared with 2012.

*(Answer) Relative Risk = Incidence₂₀₁₃ ÷ Incidence₂₀₁₂
= 1.48 ÷ 0.61 = 2.41*

(Note: Incidence₂₀₁₂ = (13 cases × 52 weeks/year) ÷ 1100 child-weeks = 0.61 cases per child-year)

(Scoring guidance: 1 point for correct set-up and 1 point for correct answer.)

21. (1 point) Which of the following statistical tests would you use to determine the statistical significance of the difference in rates? (circle best answer)

- a. T-test
- b. Fisher's exact test
- c. Paired T-test
- d. *(Answer) Chi square statistic*

You review the data in Table 1, call Dr. Brown's office, and ask his nurse about the boy admitted to Children's Hospital. She says the child was admitted for acute dehydration resulting from watery diarrhea and vomiting. He responded well to treatment and was sent home a few hours ago. A stool sample was collected when the child was admitted Sunday and test results should be available within a day or so. The initial diagnosis was viral diarrhea or

possible cryptosporidiosis—definitely not related to teething or antibiotics. You thank her for the information. You ask whether the hospital lab can speed up the testing and call you as soon as they get results. The nurse says she will do her best.

You call Beth to tell her that on the basis of the information she sent, a problem might have developed. She says they have had a terrible day so far. One of her teachers went home ill and at least three more children developed diarrhea. In one of the 4-year-old classrooms, a child had feces running down her leg. She says one child had the same symptoms the week before last, got better, and is sick again. You tell her that you spoke with Dr. Brown's office and it appears a communicable disease outbreak at the center might be occurring, and you will put together a team to visit this afternoon. You ask Beth to break down the data she sent by classroom and create a table showing the number of children with diarrhea and number of child-weeks of attendance for each classroom 8-week period. You explain to her how to calculate child-weeks of attendance.

22. (2 points) Which part of the descriptive epidemiology triad are you addressing by looking at the data by classroom?

(Answer) Place.

(Scoring guidance: accept Person, because classroom and age are linked.)

You contact the Environmental Health and Nursing units of the health department, explain the situation, and ask them to assign a sanitarian and public health nurse to accompany you on a field visit. You next contact the local office of the child care licensing agency that to let them know what is going on and what you plan to do, and invite them to send a representative along on the field visit. Finally, you call your colleague Larry Johnson at the state laboratory and talk with him about the situation. “You know, Brown may well be right on this one,” Larry says. “Several types of viruses cause watery diarrhea. Rotaviruses and noroviruses are the most common. A vaccine is available for rotavirus, and norovirus outbreaks tend to be really explosive. This outbreak seems a bit like a slow burner. That kid who was sick, got well, and then is sick again sure sounds like a recrudescence case. We see that a lot with Crypto.³ Why don't you stop by and pick up some stool collection kits? We can test for that here.”

23. (4 points) List two steps of an outbreak investigation that were addressed in the previous paragraph.

(Answer) Prepare for fieldwork.

(Answer) Verify the diagnosis.

You tell your secretary you will probably be at Child Care Facility A all afternoon. You meet Bill Rosales, the sanitarian, and Marge Kunith, the public health nurse, in the parking lot and give them the address. You tell them a colleague at the state laboratory thinks this might be a cryptosporidiosis (Crypto) outbreak and you are going to pick up some stool collection kits. You tell Bill that, in addition to his regular inspection routine, you want him to check for any water-related play activities, such as wading pools or water tables, the center might offer during the summer. You tell Marge to give special attention to child care practices in the rooms where they are diapering children and to disinfection practices.

Children using diapers are at greater risk for diarrhea than those who are toilet trained, because they explore their environment and put things into their mouths more often than older children. The majority of children are toilet trained by age 3 years. Outbreaks of diarrheal illness are less common among toilet-trained children and often involve common exposure.

³ “Crypto” refers to *Cryptosporidium sp.*

24. (2 points) What is the American Public Health Association recognized mode of transmission for most diarrheal diseases? (Note: fecal-oral is not among the APHA recognized modes of transmission)

(Answer) Vehicleborne

You pull into the parking lot at Child Care Facility A, a large facility in what was once an elementary school. You see a group of children playing with a water table and hose on the playground. Traffic was bad and you stopped by the laboratory to pick up stool kits, so you are not surprised that Bill and Marge are already inside. You introduce yourself to the receptionist and show her your identification badge. “Your colleagues are already going about their business,” she says. “I’ll page Ms. Grey. Have a seat.” You look around as you wait. The halls are clean, but with is a faint odor of chlorine. Children’s art work, including drawings of handwashing and toothbrushing, are displayed on the walls. A bulletin board has announcements of activities and a large poster telling parents not to bring their children if they exhibit a list of symptoms.

Beth soon greets you. “Hi, I’m Beth Grey, the Director. You must be the person I spoke to on the phone. Thanks for coming. Your colleagues are already checking the place out.” You explain that you would like to talk with her to find out a little bit about the facility and the situation. She shows you to a small conference room just off the main entrance.

She takes a seat and begins. “We’ve been here for almost seven years. We have 30 staff and a licensed capacity of 125 children. They don’t all come every day and we have about 150 enrolled right now. That includes our after-school kids. We don’t accept infants. We divide our kids up by age, 1-year-old, 2-years-old, 3-years-old, 4-years-old, and then the 5-years-old. We have two classrooms for each. We call them A and B and name them by the ages of the kids. Classroom 1A is one of the classrooms for our 1-year old kids. Classroom 1B is the other. Our kids move up to the next class on their birthdays. Our normal hours are 7:30 a.m. to 5:30 p.m., but we have an early morning drop-off starting at 6:30 a.m. and a late-day group that ends at 6:30 p.m. We follow the American Academy of Pediatrics recommendations for when kids should be kept home. We check our kids every morning when they arrive. Our parents tell us when their kids are sick.”

Beth slides a piece of paper across the table toward you. “I had our receptionist reorganize the information you wanted,” she says. Just then the receptionist comes to the door. “Ms. Grey, there is a call for you from Mrs. Brownlee. She heard about an “epidemic” and wants to know more about it,” she says. Beth leaves to take the call. You look at the information on the paper (Table 2) and compare the age distribution of children with diarrhea during the last 2 years.

Table 2: Number of Children with Diarrhea* and Number of Children Present** by Age Classroom for Weeks 29–36, 2012 and 2013

Classroom	Year			
	2012		2013	
	No. Ill	Child-weeks	No. Ill	Child-weeks
1A	3	99	3	107
1B	2	89	5	91
2A	1	89	8	94
2B	2	73	4	70
3A	1	105	3	110
3B	2	109	4	111
4A	1	110	2	114
4B	0	134	3	136
5A	1	151	0	153
5B	0	141	0	138

* Includes illness reported by parents and observed by care givers.

** A child was counted as being present if he or she attended one whole day that week.

25. (2 points) Which of the classrooms in Table 2 include children who are not toilet trained (assume all 3-year-olds are toilet trained)?

(Answer) 1A, 1B, 2A and 2B.

26. (2 points) If the age distribution of the children at Child Care Facility A changed substantially from 2012 to 2013, what technique would you need to use to compare the overall illness rates?

(Answer) Direct age adjustment. (2 points)

(Scoring guidance: give 1 point for stratified analysis or age adjustment, .5 point for adjustment.)

27. (16 points [2 points] each) Complete the following table. Show your calculations and express rates as units

	2012	2013	Relative Risk (2013 vs. 2012)
Diapered (Incidence Rate)	A	B	C
Toilet-trained (Incidence Rate)	D	E	F
Relative Risk: Diapered vs. Toilet-trained	G	H	

A. $I_{diapered\ 2012} = 8\ \text{ill children} \div 250\ \text{child-weeks} = 0.023\ \text{ill children/child-week}$

B. $I_{diapered\ 2013} = 20\ \text{ill children} \div 362\ \text{child-weeks} = 0.06\ \text{ill children/child-week}$

C. $RR_{diapered\ 2013/diapered\ 2012} = I_{diapered\ 2013} \div I_{diapered\ 2012} = 0.06/0.023 = 2.42$

D. $I_{toilet\ trained\ 2012} = 5\ \text{ill children} \div 750\ \text{child-weeks} = 0.0067\ \text{ill children/child-week}$

E. $I_{toilet\ trained\ 2013} = 12\ \text{ill children} \div 762\ \text{child-weeks} = 0.0157\ \text{ill children/child-week}$

F. $RR_{toilet-trained\ 2013/toilet\ trained\ 2012} = I_{toilet\ trained\ 2013} \div I_{toilet\ trained\ 2012} = 0.0157 \div 0.0067 = 2.36$

G. $RR_{diapered\ 2012/toilet\ trained\ 2012} = I_{diapered\ 2012} \div I_{toilet\ trained\ 2012} = 0.023 \div 0.0067 = 3.43$

H. $RR_{diapered\ 2013/toilet\ trained\ 2013} = I_{diapered\ 2013} \div I_{toilet\ trained\ 2013} = 0.06 \div 0.0157 = 3.82$

(Scoring guidance: give 1 point for plugging in correct cells and 1 point for right answer.)

28. (2 points) Which of the following statements are supported by the information in Table 2 and your calculations? (circle all that apply)

e. (Answer) Diapered children had greater risk for diarrheal illness than toilet-trained children during both periods.

f. Both groups experienced greater risk for diarrheal illness during 2012 than 2013.

g. The excess risk among diapered children, compared with toilet-trained children was significantly greater during 2013 than 2012.

h. (Answer) Data support a hypothesis that the increase in diarrheal illness during 2013 involved both diapered and toilet-trained children.

Beth returns a few minutes later. She tells you that Bill and Marge are nearly finished with their inspection. You tell her you saw some interesting things in the information she provided. "I've spoken with the folks at the lab and we think this might be caused by a parasite called *Cryptosporidium*, commonly called Crypto." About that time your cell phone buzzes. Your secretary is calling so you answer. "The lab just called," she says. "They were able to speed up testing and the stool from the day care child was positive for Crypto." You thank her and turn to Beth. "I think this problem might be Crypto," you say. "I have some stool containers and parent permission forms in the car. I've only got a dozen right now but I think it would be a good idea if we could collect some stool specimens from some of your kids and get them tested for Crypto." "Sure, we can set that up," Beth says. "Who do you want to test?"

19. (1 point) You have 12 stool test kits available and need to decide which children to test. Which of the following screening schemes would be the best to use if you wanted to test the hypothesis that, throughout the center, those with diarrhea have *Cryptosporidium* and those without diarrhea do not? (circle best answer)

- e. Select classrooms with the most ill children and test only those with a recent history of diarrhea.
- f. Test only children with a recent history of diarrhea, but select only one or two from each classroom.
- g. Select one or two classrooms and test a few children with a recent history of diarrhea and a group of children who have not had diarrhea (controls).
- h. *(Answer) Test a randomly selected group of children with a recent history of diarrhea and a randomly selected group of children without a recent history of diarrhea.*

20. (2 points) Which of the following screening schemes would you use if you wanted to determine the prevalence of infection among a group of students? (circle best answer)

- e. Select classrooms with the most ill children and test only those with a recent history of diarrhea.
- f. Test only children with a recent history of diarrhea, but select only one or two from each classroom.
- g. Select one or two classrooms and test a few children with a recent history of diarrhea and a group of children who have not had diarrhea (controls).
- h. *(Answer) Select the classroom with the most ill children and test everyone, even if they do not have a recent history of diarrhea. (2 points)*

You know that noninfectious diarrhea is a fairly common occurrence in young children and decide to test ten children with a recent history of diarrhea from different classrooms and two children who have not had diarrhea.

Bill and Marge come into the room as you finish explaining your testing plan to Beth. You ask her to leave the room so you can hear their reports in private. "Okay, it looks like we have a Crypto outbreak here," you say. "At least the boy who was hospitalized this last weekend tested positive. What did you find?"

Marge speaks first. "Well the children in the 1-year-old rooms were having their nap time so I did not get to see much. I spent most of my time in the 2-year old rooms. They have two rooms for each age group and use dividers to break the rooms up into smaller areas. The second was a real zoo. One of the children had an 'accident.' Feces were running down the poor kid's leg and the others were all screaming 'pooeey,' 'stinkkeee,' stuff like that at him. Fortunately, he was on a tiled surface and the aides followed the accepted protocol while cleaning up the mess. I was a bit concerned to see one of the aides wash the child's backside off in the sink before diapering him."

Marge continues. "The setup was pretty much the same with the 3-year-olds. They have a child-sized toilet in the corner and a little handwashing sink. The sink had a bunch of toys in it that were going to be washed in the dishwasher. They were serving snacks in one of the rooms and the children were helping pass out cookies. I asked about hand-washing and the teachers told me that the servers were very careful and all used hand sanitizer."

21. (4 points) List four of Marge's observations that could have contributed to this outbreak.

(Answer) One of the aids had washed the kid's backside off in the sink before diapering him.

(Answer) The sink had a bunch of toys in it.

(Answer) The kids were helping to pass out cookies.

(Answer) Servers were very careful and all used hand sanitizer.⁴

Then Bill reports. “I checked the food service area. All meals are prepared offsite and delivered as individual servings to the center daily. They are refrigerated until just before lunchtime, heated in a convection oven, and brought to the classroom where they are served. Drinks are individual sealed servings, you know, the type where you use a straw to punch a hole in a seal. The utensils and serving units are all disposable so there is very little dishwashing needed. The receptionist does all the food preparation and heating. She says she never changes diapers at the center. The refrigeration was working fine. The kitchen area was pretty clean, although I did tell them they needed to change the fly strip, because it was getting crowded. All chemicals and cleaning materials were stored correctly. I really did not find much to cause concern.”

Bill continues. “The playground was in good shape. Equipment was all in good repair and more than the required amount of shock-absorbent material under the swings and climbing equipment was available. The sandboxes all had covers to keep the neighborhood cats out and they looked like they were in good repair. I did not see any wading pools, but there were a couple water tables.⁵ One was being used when I was there. I asked about handwashing. The teacher told me the children all used hand sanitizer before water play. I did see a couple of children drinking the water. The teacher told me that the water tables are emptied and cleaned out at the end of the day or when the water gets dirty. They hose the tables out, turn them upside down, and let them air dry. The toys used in the water tables are just allowed to air dry.”

31. (3 points) List three of Bill’s observations that are cause for concern in regard to this outbreak.

(Answer) All children used hand sanitizer before water play. (1 point)

(Answer) He observed a couple of the kids drinking the water. (1 point)

(Answer) Water tables are emptied and cleaned out at the end of the day. (1 point)

(Answer) Staff hosed water tables clean, turn them upside down and let them air dry. (1 point)

(Answer) Toys used in the water tables are just allowed to air dry. (1 point)

(Scoring guidance: any three of the above.)

You tell Bill and Marge that you want to screen some of the children for Crypto. You discuss recommendations with them, making sure they agree and that you have covered all points. Marge points out that the facility currently allows children with diarrhea to attend as long as their diapers can contain the stool. After feces have leaked out, it is too late to do much other than clean up the mess. She suggests you recommend changes to the center’s attendance policy.

In making recommendations concerning the prevention and control of illness, disease detectives want to make sure recommendations are both effective and reasonable. For example, closing the facility would certainly stop further transmission, but would pose undue hardship on both the staff and families. Parents might place their infected children in other programs and spread the problem further.

⁴ Cryptosporidium is resistant to alcohol – hand-washing would be the correct procedure

⁵ Water tables are wood or plastic tables with raised 4–6-inch edges. They are filled with water or sand and young children play in them with boats, cups, and other toys. Although children can splash and pour water on each other, usually only their hands and arms get into the water.

32. (3 points) Which of the below recommendations would you make concerning this outbreak? (circle all that apply)
- a. *(Answer) Exclude all children with diarrhea until their diarrhea is resolved.*
 - b. Screen all children and staff and allow only noninfected persons to enter the facility.
 - c. Screen all children, staff, and household contacts and exclude all persons who were infected or were household contacts of infected persons until they were no longer infected whether they had diarrhea or not.
 - d. Implement a program of daily disinfection of floors, walls, ceilings, and other environmental surfaces throughout the building.
 - e. *(Answer) Instruct the staff in proper handwashing, diapering, and other hygiene activities and monitor their performance.*
 - f. *(Answer) Exclude children with diarrhea from using water tables.*
 - g. Install hand sanitizer dispensers throughout the facility and encourage both children and staff to use them rather than washing their hands.

After you talk with Bill and Marge, you call Beth into the room and discuss your recommendations with her. You write them down and ask to have them photocopied so you can leave a set with her. You arrange to pick up the stool specimens in 2 days, agree to stay in touch, and leave to go back to your office.

Late Wednesday afternoon, you get a call from Larry at the state laboratory. He received the stool specimens from Child Care Facility A and should have results for you by the close of business on Thursday. He points out that the test they use has a sensitivity of only 75% for single-stool specimens and that you might want to consider getting multiple specimens from each child. You tell him you will consider that option and get back to him.

33. (4 points) The sensitivity of the laboratory test for Crypto is 75%, the specificity is 100%, and the true prevalence of infection is 20%. If you screen 100 children, how many infections will you miss? (Show your calculations.)

(Answer) Five infections will be missed.

Sensitivity = .75% Sensitivity = $TP \div (TP + FN)$. (1 point)

Prevalence = 20% of 100 = 20 = $TP + FN$. (1 point)

.75 = $TP \div 20$

$TP = .75 \times 20 = 15$

$FN = 20 - 15 = 5$ infections missed.

(Scoring guidance: 1 point for right formula for sensitivity, 1 point for correct use of prevalence, 1 point for putting data in correctly, and 1 point for correct answer.)

34. (4 points) If you were to screen each child twice and consider a child to be infected if either specimen is positive, what would be the sensitivity of the test? (Show your calculations.)

(Answer) Sensitivity of two tests = $1 - .25^2 = .9375$

Sensitivity = $TP \div (TP + FN) = .75 = .75 \div 1$. $FN = 1 - .75 = .25 =$ probability of being FN on one test, probability of being FN on two tests = $.25^2$

(Scoring guidance: 4 points for correct answer, 3 points for focusing on .25, 2 points for focusing on .75, and 1 point for knowing sensitivity would improve.)

You call Beth at Child Care Facility A before you leave for the day and ask her how things are going. She says multiple episodes of diarrhea in various classes throughout the facility have been reported, but the majority were among children who were ill before. However, three children had diarrhea for the first time. Two are in the 3-year-old group and one is in the 4-year-old group. The latter has a brother in the toddler class who was ill last week. You tell her you should have results back on Thursday and you will visit Friday morning to discuss follow-up activities.

At midafternoon on Thursday, one of your staff stops by your office to tell you that the laboratory put a rush on testing your specimens and the results are ready. She combined the laboratory results with other information from the children who were tested into a single table that she gives you to review (Table 3). She tells you the laboratory has already contacted the pediatricians of each child tested. They will notify the parents of children who were tested and give them the results. Confidentiality laws do not allow you to give this information directly to Beth, but the parents were told they need to tell her about the results. After that is done, you can discuss the situation with her.

Table 3: Results of Initial Screening for *Cryptosporidium* at Child Care Facility A

Result	Classroom	Week Onset	Symptomatic
Positive	1A	35	Yes
Positive	1A	36	Yes
Positive	2A	36	Yes
Positive	3A	35	Yes
Positive	3A	36	Yes
Positive	4B	36	Yes
Negative	1B	36	Yes
Negative	2A	35	Yes
Negative	2B	36	Yes
Negative	4B	35	Yes
Negative	1A	NA	No
Negative	1A	NA	No

35. (2 points) Give two explanations for the four negative test results from children with symptoms.

(Answer) Their illness was caused by something other than Crypto.

(Answer) An error in the test or collection was encountered.

(Answer) They had recovered from illness by the time specimens were collected.

(Scoring guidance: accept any of the above or variants.)

36. (4 points) Now that you have a good idea about the agent responsible for this outbreak, write a case definition that you can use for the remainder of the investigation.

(Answer) — Definition should address each of the four following attributes.

- Clinical information about the disease, including a history of watery diarrhea.)*
- Information about the location or place, Child Care Facility A.*
- Characteristics about persons who are affected (e.g., staff or child).*

- *A specification of time during which the outbreak occurred, during weeks 34–37, 2013.*

(Scoring guidance: accept positive test for *Crypto* instead of or with watery diarrhea; give 1 point extra if they use this as confirmed versus suspect cases.)

You finish reviewing the results and call Beth. She says that several parents have already contacted her about the children's results. She is really concerned because they have had more children and staff with diarrhea during the last week than in any previous week. The majority of classrooms have had at least one ill child. Certain parents told Beth they were thinking of moving their children to another child care program because they are concerned that the problem is growing and everybody might eventually be infected. You ask Beth to send you the names and classrooms of the additional children with diarrhea and discuss a second round of testing with her. You also call Larry to thank him for expediting the results. You discuss the possibility of testing all the children and staff who have not been screened previously and send him a copy of the table by e-mail. Larry says the laboratory can handle the specimen load for testing everyone in the center but it will take a day or so to get material together.

On Friday afternoon you call Beth and ask how things are going at the center. She sounds a bit dejected and she tells you they have done everything you recommended, but are winding up the week with more children with diarrhea than they had the week before, not to mention that children who they thought had recovered are getting diarrhea again. You explain to her that it can take a week or more for symptoms to develop after a person has been infected with *Cryptosporidium* and many of the newly ill people were probably infected before the control measures were put in place. You explain that recrudescence, or recurrent bouts of diarrhea, is common with *Crypto* and that the best way to prevent additional cases is to adhere to the guidelines for preventing spread of infection. You tell her you will come by Monday to set up testing for all children and staff.

First thing Monday morning you pick up the supplies needed to test everyone at Child Care Facility A. When you arrive at the facility to drop off the supplies, you notice that the facility seems different than it did a week ago, including fewer children and less of a bleach odor. The water tables are gone from the playground and the wastebasket next to the sink in one of the classrooms is full of used paper towels. When you mention these observations to Beth, she says they are not using as much bleach and have switched to disinfecting with peroxide until the outbreak ends. Staff also stopped using hand sanitizer and is having the children wash their hands with soap and water when they arrive in the morning. She says they were going to follow your recommendations about cleaning the water tables, but were concerned that children who were infected and did not have diarrhea would contaminate them. "The weather is getting cooler anyway and we thought it best to just put them up," she says.

Beth and another staff person help you unload the test supplies from your car. You go over the instructions and make sure staff knows what to tell parents. After you review plans for picking up the samples, getting them to the laboratory, and managing additional cases, you head off for a meeting with the infection control practitioners in your area.

On Friday you call Beth. She says sample collection is going well and they have had substantially fewer children getting diarrhea during the past week than the week before. Recurrence is still a problem, but the situation seems improved. You make it clear that the reduction is attributable to their improved hygiene practices, not to screening.

Approximately 2 months have passed and you are piecing together the data from the Child Care Facility A outbreak. You compare the results of the facility-wide testing with reports of watery diarrhea among children and staff (Table 4).

Table 4: Results of Facility-wide Screening (Test 2) for *Cryptosporidium* Among Children and Staff Who Were Symptomatic (Reported Watery Diarrhea) or Asymptomatic

Symptomatic	Screening Results	
	Positive	Negative
Yes	41	12
No	10	120
Total	51	132

37. (2 points) What was the attack rate of laboratory-confirmed *Cryptosporidium* infection among children and staff at Child Care Facility A during weeks 32–40? (Show your calculations.)

(Answer) $Prevalence = \text{number of cases} \div \text{total population} = 51 \div 183 = 27.9\%$.

(Scoring guidance: give 1 point for formula and 1 point for correct calculation.)

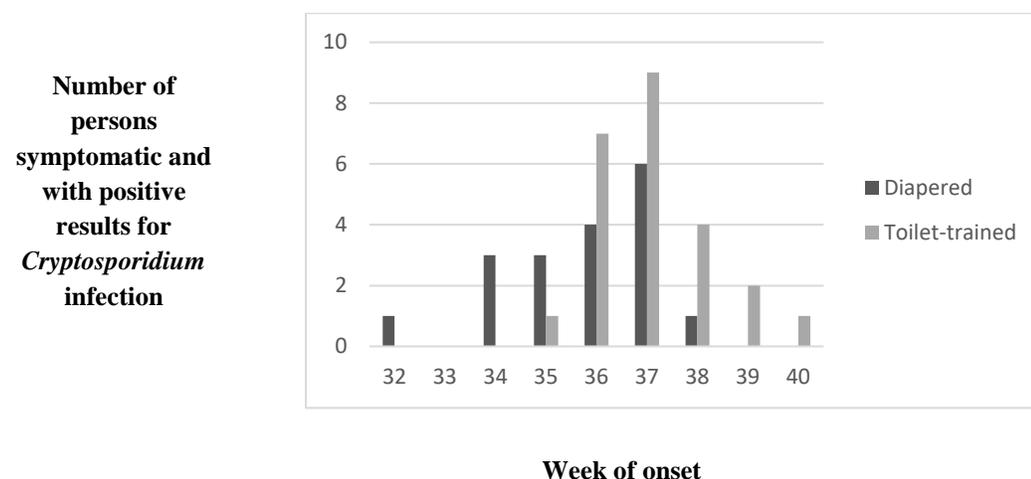
38. (4 points) Using the laboratory test as the ultimate standard for identifying persons with *Cryptosporidium* infections, what is the specificity of using watery diarrhea as an indicator? (Show your calculations.)

(Answer) $Specificity = TN \div (TN + FP) = 120 \div (120 + 12) = 90.9\%$.

(Scoring guidance: give 1 point for formula, 2 points for using correct numbers and 1 point for correct calculation.)

You create a histogram showing the number persons who were both symptomatic and whose stool test results were positive for *Cryptosporidium* infection in diapered and toilet-trained classes (Figure 1).

Figure 1: Number of Persons with Symptoms and Positive Results for *Cryptosporidium* Infection in Diapered and Toilet-Trained Classrooms, by Week of Symptom Onset



39. (2 points) What does the data in Figure 1 indicate about where the outbreak started and where it ended?

(Answer) The outbreak appears to have started among the diapered children (1 point), and then spread to toilet-trained children. (1 point)

40. (3 points) On the basis of what you have been told about practices and conditions in this child care facility, list three ways that *Cryptosporidium* infection might have spread from one of the above groups to the other.

(Answer) They shared the same water tables.

(Answer) Transmission at home.

(Answer) Transmission among early drop-off and late pick-up groups.

(Scoring guidance: question addresses transmission among diapered and toilet-trained children, but not among children in same age groups. Accept any reasonable answer. Examples given above.)

41. (2 points) How can you explain the fact that your prevention measures were started at the beginning of week 37 yet the greatest number of cases among both diapered and toilet-trained persons occurred during that week (i.e., were your measures effective or not)?

(Answer) Measures were effective. Crypto has a substantial incubation period and those who became ill during week 37 were probably infected before prevention measures were implemented.

42. (6 points) List three broad recommendations you would make for all child care programs in your area to prevent this sort of outbreak from happening again.

(Answer) Educate staff and parents.

(Answer) Exclude any child with diarrhea from the child care setting until the diarrhea has stopped.

(Answer) Establish, implement, and enforce policies concerning water-play and swimming.

(Answer) Practice good hygiene.

(Answer) Reinforce the need for correct diapering practices.

(Answer) Disinfect surfaces and objects, including but not limited to bathrooms, diaper-changing areas, food-preparation areas, tabletops, high chairs, and toys.

(Answer) Notify the state or local health department about an excessive level of diarrhea or any Crypto cases in the child care facility. Crypto is a nationally reportable disease.

(Scoring guidance: accept paraphrasing of any of the above recommendations or other reasonable ones. Competitors can include more than three answers, but only score the first three.)