Don't Drink the Water: Investigating a Cholera Epidemic

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In collaboration with the Centers for Disease Control and Prevention's
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Students will learn about the scientific method and the characteristics of life by assuming the role of epidemiologists. The scenario that they will investigate is that many individuals in the school have recently become ill with gastrointestinal symptoms (vomiting, diarrhea, dehydration, and headache). Students will discover the source of the illness, the microbe causing the illness, and the biology behind the organism spreading the disease. By examining "stool samples" made from molasses and water, students will examine differences between affected and unaffected individuals. The students will eventually determine the source of the outbreak is contaminated water in the school cafeteria and conclude that the microbe involved is a bacterium called cholera. Students will then conclude the lesson by investigating an outbreak of birth defects. The target grade level for this lesson plan is 9th and 10th graders.

Disclaimer: The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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Summary
Students will learn about the scientific method and the characteristics of life by assuming the role of epidemiologists. The scenario that they will investigate is that many individuals in the school have recently become ill with gastrointestinal symptoms (vomiting, diarrhea, dehydration, and headache). Students will discover the source of the illness, the microbe causing the illness, and the biology behind the organism spreading the disease. By examining "stool samples" made from molasses and water, students will examine differences between affected and unaffected individuals. The students will eventually determine the source of the outbreak is contaminated water in the school cafeteria and conclude that the microbe involved is a bacterium called cholera. Students will then conclude the lesson by investigating an outbreak of birth defects. The target grade level for this lesson plan is 9^{th} and 10^{th} graders.

Learning Outcomes

- Students will be able to apply the scientific method to determine the source and cause of the outbreak.
- Students will be able to identify the characteristics of life by examining the "microbes" contained in the specimens.
- Students will be able to apply their investigative epidemiological skills to solve another mystery—children born in the 1960s with malformed limbs.
- Students will discover that the birth defects were caused by the drug thalidomide by reading an article and answering questions.

Materials

1. Two bowls
2. 200 mL molasses
3. 40 mL gelatin
4. 40 mL water
5. 5 grams of yeast (cholera)
6. Watch glasses
7. Petri dishes
8. Table sugar
9. Dissecting microscopes
10. Compound light microscopes
11. Slides and coverslips
12. Rubber gloves
13. Goggles
14. Forceps
15. Biohazard bags

Total Duration
2 hours, 30 minutes

Procedures

Teacher Preparation
To create the "stool samples," mix 200 mL molasses, 40 mL water, and 40 mL gelatin in a large bowl. Set one half of the sample aside; this is the healthy stool. Add 5 g yeast to the second sample; this is the affected stool. Mold the samples into desired shapes and create enough samples for each lab group. Place the specimens on watch glasses, cover them, and set them aside, out of students' view. Prepare class copies of all handouts – found in the Introduction, Step 2, Step 4 and the Conclusion.

Introduction
The purpose of this lesson is to use the scientific method to solve an epidemiological outbreak. To begin this lesson, inform the class that an outbreak has occurred in the school and large numbers of students are exhibiting gastrointestinal symptoms. The Centers for Disease Control and Prevention (CDC) has asked the biology classes to determine both the source and cause of the disease by performing an epidemiological investigation. Explain that epidemiology is the study of the determinants, occurrence, and distribution of health and disease in a defined population, and that students will investigate a possible outbreak of disease in their school. This definition might be difficult for students, so ask students if they can think of examples of outbreaks that they have heard about in the news. Discuss how these outbreaks have determinants (possible 'causes'), occurrence (when it happened), and distribution (where it happened).

Tell the students that CDC would like to assess their prior knowledge of the scientific method and the characteristics of life, so that CDC can make sure that the students have all the knowledge they need to begin the investigation. Then administer the Scientific Method and Characteristics of Life Pretest to assess students' prior knowledge of these topics. After the pretest, go over the answers to Part A of the pretest. This section goes over the steps of the scientific method.

To introduce students to epidemiology and how it is used to investigate an outbreak, students should review the Web site Steps of an Outbreak Investigation. Epidemiologists use steps very similar to the scientific method; however, they have several steps that they do before they formulate a hypothesis. These include establishing that an outbreak has occurred, verifying the diagnosis, developing definitions for cases (developing criteria to determine who will be considered as having the condition or not), and describing some of the data they have collected in terms of person, place, and time. Students will have a chance to do some of these initial steps as well as follow the remaining steps of the scientific method (which are very similar to how an epidemiologist concludes his/her investigation).

Web Resource
Title: The Scientific Method
URL: http://koning.ecsu.ctstateu.edu/Plants_Human/scimeth.html
Description: This Web site from Eastern Connecticut State University goes through the steps of the scientific method and can be used to better understand the process.

Title: Steps of an Outbreak Investigation
URL: www.cdc.gov/excite/classroom/outbreak/steps.htm
Description: This Web site from CDC takes students through how epidemiologists conduct outbreak investigations.

Supplemental Documents

Title: Scientific Method and Characteristics of Life Pretest
Description: This Word document contains a pretest to assess prior knowledge of the steps of the scientific method and the qualities that make something alive.

Title: Scientific Method and Characteristics of Life Pretest Key
Description: This Word document contains the answer key to the Scientific Method and Characteristics of Life Pretest.

Step 2 **Duration: 30 minutes**

1. Inform the class that you have received a request from CDC to help them understand a possible outbreak in their school. According to CDC, 100 students in their school have become ill over the past week. The students have been asked to help determine whether this is, in fact, an outbreak and, if so, determine the cause. Have students discuss the possibility that an outbreak has actually occurred. Students might assume that there is an outbreak because of the number of sick individuals. During this discussion, guide students to think about whether or not the number of students who are sick would be enough to constitute an outbreak. At this time, the concept of observed versus expected could be discussed. How many students would we expect to be sick in a given time? How many students are actually sick during that time? Reveal that the school nurse's log indicates that there have been no more than two cases of gastrointestinal illness reported in any of the last 6 months. Have students calculate the ratio of the number of cases we would expect versus what the school nurse has seen this past week and report that to the health department. Once students have discussed these ratios, inform students that you have spoken with CDC and the number of sick individuals indicates there is an outbreak. So, the class has some work to do to figure out what is happening!

2. CDC has sent a sample of some of the case histories of students in their school. Divide the students into groups of four and give each student a Case History Card. Inform the students that a case history is a tool that epidemiologists use to interview individuals to determine the source of an outbreak. For this activity, the card each student receives details what foods and beverages the student had consumed recently and whether they are experiencing any symptoms.

3. In their groups, have students compare their cards with those of other group members and discuss the illness (or verify the diagnosis). There are eight different Case History Cards; three of the cards represent affected individuals. *Teacher should ensure that each group has at least one card that has an affected individual.*

4. Now that students know there is an outbreak and they have verified the diagnosis, they need to work on defining a case. Lead a class discussion to allow students to decide what symptoms are common in all sick individuals and will ultimately define their case. Students might come up with someone who has an upset stomach or stomach pain, whose legs are cramping, and who has been vomiting.

5. CDC has asked the students for several pieces of information that will help describe the data in terms of person, place, and time. In addition to describing the data, CDC would like to see a 2X2 table that epidemiologists use to calculate relative risk—that is, to see how likely it is that someone who was exposed actually got the disease. To gather this information, have each student should fill out the Data Collection Tool worksheet.

6. Once the students have completed the Data Collection Tool, have them get back in their same groups to discuss possible sources of the illness based on all of their previous work . From the information given on the cards, the students will be able to identify the source as fruits and vegetables from the cafeteria. Probe them to think deeper by asking them, “Think of similar exposures that all of the fruits and vegetables might have had.” Each group can share its hypothesis with the class. Ideally, students will point out that all of the fruit and vegetables were washed with water from a common source. Confirm that water is indeed the source of the illness.

7. Link what has occurred so far to the first step of the scientific method: observing and describing a phenomenon. Elicit ideas from the class on how this step should be written; note ideas on the board. For example: “Six students in the class have exhibited gastrointestinal symptoms and the source has been linked to contaminated water from the cafeteria.”

8. The second step of the scientific method is to develop a hypothesis. Ask students to suggest ways to write what they observed as a hypothesis using an “If…then” format. Write their hypotheses on the board. For example: “If students eat fruit washed with water from the cafeteria, then they will become ill with gastrointestinal symptoms.”

   This hypothesis is sufficient for now but should be expanded upon in the next section. In step 3, students will design an experiment to test their hypothesis.

   Supplemental Documents
   Title: Case History Cards
   Description: This Word file contains case history cards for use in the outbreak investigation. There are eight different cards; three represent affected individuals.

   Title: Data Collection Tool
   Description: This Word file contains a worksheet that will help students describe the data in terms of person, place, and time.

   Title: Data Collection Tool Answer Key
   Description: This Word file contains a worksheet with the answers describing the data in terms of person, place, and time.

Step 3 **Duration: 30 minutes**

1. Now that the source (the water) has been identified, ask the class what they think would be a logical next step for an epidemiologist to determine what about the water is causing the illness. Students will probably suggest that water samples from the school be tested. This is the third step of the scientific method—designing and performing an experiment to test the hypothesis. Inform them that, unfortunately, your biology class does not have the equipment needed to test the water directly for toxins, microbes, etc. Encourage the students to think of samples that they can test aside from the water, specifically stool samples.

2. Put on gloves and goggles and reveal the stool samples that were prepared in the teacher preparation section. Students should treat the samples as if the samples are real.

3. Working in groups of four, have the students examine the stool samples from both an affected and an unaffected individual and note the differences. They should wear gloves and goggles during this step and use dissecting microscopes to observe the specimens and forceps to manipulate the specimens.

4. When the students are finished analyzing the samples, dispose of the stool samples in a biohazard bag and disinfect the tools and lab benches.

5. Elicit a discussion of what differences they observed between the two samples. These are the fourth and fifth steps of the scientific method, analyzing the data and pooling class results. Students will likely point out that there were “dots” or “flakes” in the affected stool samples, but not in the healthy stool samples.

6. Ask the class if they think the hypothesis should be rewritten. This is step six of the scientific method. For example, “If students eat fruit washed with water containing small dots from the cafeteria, then they will become ill with gastrointestinal symptoms.”

Step 4 **Duration: 45 minutes**

1. Now that the students understand how an epidemiologist uses the scientific method to determine the outbreak’s source (cafeteria water) and cause (small dots in the stool), get them to question what the dots in the affected stool could be. This is part of the scientific method, revising the hypothesis as more information becomes available. Ask questions such as “Do you think they are alive?”; “What qualities do you think makes something alive?”; and “How do you think a scientist tests to see if something is alive?”

2. Inform the students that there are seven traits that scientists have determined as the characteristics of life. In order for an organism to be alive, it must possess all seven of the traits. An easy way to remember the seven characteristics is the acronym “G.O. S.H.A.R.E.” Write this acronym on the board and have the students take notes on what each letter refers to.

   G = growth and development; O = organized into cells, tissues, and organs; S = responds to a stimulus; H = maintains homeostasis; A = adapts and evolves; R = reproduces; and E = requires energy. Also, point out that, frequently, students think that breathing and moving are characteristics of life. However, not all organisms breathe oxygen; some are chemotrophs and live off chemicals like sulfur compounds or methane. Likewise, not all organisms move. For example, plants are rooted to the ground and barnacles are attached to rocks. To reinforce these seven characteristics, you may wish to have the students complete the G.O. S.H.A.R.E. Activity at the end of this section under Supplementary Documents.

3. Now that the students know the seven characteristics of life, have them test to see if the dots from the afflicted stool samples exhibit those characteristics. Students will not be able to observe two of the seven characteristics (growing and adapting and evolving), so be sure to point that out to the students.

4. At this point, remember that the students still do not know what the dots are. Do not tell the class that they are yeast! Recall that while we are using yeast in this lab, they are supposed to represent cholera bacteria. In substep #7 below, they will determine this by reading about the historical cholera outbreak in London. For now, they just need to

determine if the dots in the stool are alive or not alive. To test to see if the dots are alive, put some yeast, sugar, and warm water into a petri dish to activate them. Then place samples onto microscope slides and add cover slips. Set the slides under compound light microscopes for the students to observe the dots up close. If the students do not yet know how to use a compound light microscope, put the slides into focus for the class.

5. Have the students observe the dots and see if the seven characteristics are exhibited. For example, they will see the yeast and sugar crystals so encourage students to link them together and to realize the sugar is food or energy for the dots. In the G.O. S.H.A.R.E. acronym, the sugar represents “E = requires energy.” Also, they should see that some of the yeast are budding. This represents “R = reproduce.” Most of the characteristics can be directly observed this way.

6. Once the students have observed the dots under the microscope, discuss as a group if the dots are alive. Hopefully they will come to the conclusion that they are indeed living organisms, despite the fact that not all seven characteristics can be observed directly.

7. To reveal to the students that the dots are the bacteria cholera, have them read Dr. Snow and the Scientific Method in the supplemental documents below and answer the questions with the reading. This document is a historical account of a mysterious outbreak in London and how Dr. John Snow discovered the source of the epidemic to be from a common water source that contained the bacteria cholera. Then link this reading back to the dots by asking them questions such as “What do you think the living dots were in the stool samples? Hopefully they will say bacteria, but more specifically the bacteria cholera. However, it should be noted that any number of bacteria could have caused this illness and is not limited to cholera, especially given that cholera is very rare in the United States.

8. Ask the students how they can complete the last step of the scientific method, namely sharing the results with the scientific community and the public (or those affected). Ideally they will suggest that they share the results with the health department, CDC, and with the student body. Students can engage in a discussion about the best way to get their message out (e.g., through meetings, student newsletters, student town hall meetings, scientific articles, etc.). Additionally, the teacher can bring up that there are different ways to deliver scientific information based on the audience you want to reach.

9. Finally, tell students that another letter has just been received from CDC. They are thrilled with how much work the class has done with the outbreak; however, an epidemiologist wanted to make sure that this final hypothesis (that water was the culprit) addressed the causal criteria that are necessary. (Please remember that meeting all criteria is not necessary, but each one should be addressed). The causal criteria are 1) biological plausibility, 2) timing, 3) strength, 4) dose response, and 5) consistency. Lead the students in a final discussion to ensure that their hypothesis is correct. For example, does water make sense as a vehicle for the outbreak? Could this happen biologically? The answer is yes. Does it make sense with the timing of the outbreak? There isn’t information about the timing of when the water was contaminated, but everyone did get sick at the same time, so yes, this makes sense, too. The strength of the association shows people who were exposed (had fruits and vegetables) were 14.3 times as likely to get the disease then people who were not exposed. This is a very strong association. Was there a dose response relationship? In other words, did people who had a greater exposure have worse symptoms? This is hard to determine because we do not have

enough information. And, finally, is this consistent or has this been replicated? This is also hard to determine but using Dr. Snow's cholera outbreak example, we do have a precedent of this type of outbreak occurring.

Web Resource
Title: Broad Street Pump Outbreak
URL: www.ph.ucla.edu/epi/snow/broadstreetpump.html
Description: This Web site from the UCLA Department of Epidemiology tells the story of Dr. John Snow and the Broad Street pump outbreak of cholera in London and is used to explain what the dots in the stool samples are.

Supplemental Documents
Title: G.O. S.H.A.R.E. Activity
Description: This Word document contains a worksheet reviewing the seven characteristics of life. To reinforce the seven characteristics of life, this activity has students choose an organism and draw it, exhibiting the characteristics of life in a pie chart.

Title: Dr. Snow and the Scientific Method
Description: This Word file contains a discussion worksheet on the article Broad Street Pump Outbreak.

Title: Dr. Snow and the Scientific Method Key
Description: This file contains the answer key to the Dr. Snow and the Scientific Method worksheet.

Conclusion **Duration: 45 minutes**

1. To conclude this lesson, first go over the answers to the Dr. Snow worksheet.

2. To help students apply their knowledge of epidemiology and to assess students' understanding of the process of epidemiology, tell the students that CDC appreciated their hard work on the cholera investigation and would like them to participate in another investigation. This next case involves the drug thalidomide, a sedative prescribed to pregnant women to prevent morning sickness in the 1960s that was associated with serious birth defects.

3. First have them watch an animated version of the song "We Didn't Start the Fire" (see Web Resources). One line in this song is "Children of Thalidomide" and it depicts a boy with fin-like limbs at a chalkboard. Now that the students are curious about thalidomide, have them go to the website "Research in the News: Thalidomide" (see Web Resources). Instruct the students to read the Web site and fill out the Children of Thalidomide Posttest.

4. Discuss the answers to the Posttest with the students.

Web Resources
Title: We Didn't Start the Fire
URL: http://home.uchicago.edu/~yli5/Flash/Fire.html
Description: This Web site from the University of Chicago plays the Billy Joel song "We Didn't Start the Fire" and depicts images of each topic referenced. It is used to introduce

the Children of Thalidomide topic. Please note: this Web site requires the use of Flash software.

Title: Research in the News: Thalidomide
URL: http://science-education.nih.gov/nihHTML/ose/snapshots/multimedia/ritn/Thalidomide/index.html
Description: This Web site from the National Institutes of Health describes the history of thalidomide and discusses new uses for the drug. The article is about pregnant women who were prescribed thalidomide in the 1960s and how their children were born with malformed limbs. Students will read this Web page and then answer questions about the article.

Supplemental Documents
Title: Children of Thalidomide Posttest
Description: This Word document assesses student comprehension of the Children of Thalidomide article.

Title: Children of Thalidomide Posttest Key
Description: This Word document contains the answer key to the Children of Thalidomide worksheet.

Assessment

In the introduction, students' knowledge of the scientific method is assessed using a worksheet. In step 4, the students' knowledge of the characteristics of life and their understanding of the process of epidemiology is assessed using two worksheets. In the conclusion section, students are assessed on their understanding of the process of epidemiology by reading an article on thalidomide (Research in the News) and answering questions from the Children of Thalidomide Posttest on what types of birth defects it caused.

Modifications

Extensions
As an extension of the epidemiology cholera theme, use this idea to further expand into cell structures and bacterial cells. For instance, now that students understand that cholera is a bacterial infection, teach cell types (plant, animal, bacteria) and link this new knowledge to their understanding of cholera. By keeping with a larger theme, students will better understand the scientific process.

Other Modifications
Students can use the Internet to research other case study exposures that led to birth defects.

Education Standards

National Science Education Standards
SCIENCE AS INQUIRY, CONTENT STANDARD A:
As a result of activities in grades 9–12, all students should develop

- **Abilities necessary to do scientific inquiry**
- **Understandings about scientific inquiry**

HISTORY AND NATURE OF SCIENCE, CONTENT STANDARD G:
As a result of activities in grades 9–12, all students should develop understanding of

- **Science as a human endeavor**
- **Nature of scientific knowledge**
- **Historical perspectives**

The Scientific Method and Characteristics of Life Pretest

Don't Drink the Water! Investigating a Cholera Epidemic
Rebecca Johns, CDC's 2005 Science Ambassador Program

A. Put the steps to the scientific method in order from 1 to 7.

_____ Design and perform an experiment to test the hypothesis.

_____ Analyze the data.

_____ Repeat the experiment or pool class data.

_____ Publish the results/share the results with the scientific community.

_____ Observe and describe a phenomena.

_____ Accept, reject, or refine the hypothesis.

_____ Formulate a hypothesis to explain the phenomena.

B. Not all the statements written below are a characteristic of all living things.
Write T (true) or F (false) next to each statement.

1. _____ All living things breathe.

2. _____ All living things grow and develop.

3. _____ All living things reproduce.

4. _____ All living things are organized into cells, tissues, and organs.

5. _____ All living things respond to a stimulus.

6. _____ All living things maintain homeostasis.

7. _____ All living things adapt and evolve.

8. _____ All living things move.

9. _____ All living things require energy.

The Scientific Method and Characteristics of Life Pretest Key

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A. Put the steps to the scientific method in order from 1 to 7.

__3___ Design and perform an experiment to test the hypothesis.

__4___ Analyze the data.

__5___ Repeat the experiment or pool class data.

__7___ Publish the results/share the results with the scientific community.

__1___ Observe and describe a phenomena.

__6___ Accept, reject, or refine the hypothesis.

__2___ Formulate a hypothesis to explain the phenomena.

B. Not all the statements written below are a characteristic of all living things.
Write T (true) or F (false) next to each statement.

1. __F___ All living things breathe.

2. __T___ All living things grow and develop.

3. __T___ All living things reproduce.

4. __T___ All living things are organized into cells, tissues, and organs.

5. __T___ All living things respond to a stimulus.

6. __T___ All living things maintain homeostasis.

7. __T___ All living things adapt and evolve.

8. __F___ All living things move.

9. __T___ All living things require energy.

Case History Cards

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Name: _____ I have been feeling fine and therefore didn't visit a doctor. On Monday, I had chicken nuggets, fries, and a Coke from the cafeteria. On Tuesday I had a slice of pizza, bread sticks, and a Coke. On Wednesday, I had tacos and a Coke.	Name: _____ I haven't been feeling good lately and have had an upset stomach today. My legs started cramping up, too, so I plan to go to the doctor if I get worse. I ate a salad and drank a bottle of water for lunch on Monday. Then yesterday, I had a slice of pizza, an apple, and a bottle of water. Today I didn't feel much like eating, so I had a bottle of water and soup.
Name: _____ I feel great. I have no symptoms of any illness like some of the other students in the school. On Monday, I brought a lunch from home where my mom packed me a peanut butter and jelly sandwich and chips. Tuesday, was pizza day so I had a few slices of pizza and a Coke. Today I had a salad, soup, and a bottle of water.	Name: _____ My stomach is killing me so I called home and will be leaving school soon. For the past month I have been dieting, and all I eat are fruits and veggies. Each day in the cafeteria, I either eat a fruit salad or chicken salad with a diet Coke.
Name: _____ I have no symptoms of being sick. I pretty much eat sandwiches for lunch most days. I think on Monday I had a turkey sandwich, chips, and a Coke. Then Tuesday I had a tuna sandwich, and today I had turkey again.	Name: _____ My stomach has been fine, I feel wonderful. I don't usually eat the cafeteria food because I eat healthier than what they offer. I bring my own lunches to school and the only items I buy from the school are sodas.
Name: _____ I vomited last hour and am going home to get some rest. I am feeling horrible and my legs are cramping. I ate a fruit bowl and drank a bottle of water on Monday from the cafeteria. Then yesterday I had soup, salad, and juice. Today I had half a tuna sandwich and a bottle of water.	Name: _____ The past few days I have felt normal, no complaints. On Monday I wasn't in school so I ate a chicken dinner at a restaurant. Then yesterday I had a grilled cheese sandwich, tomato soup, and a Coke. Today I had a burger, fries, and a Coke.

Data Collection Tool

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The health department has provided a sample of the data with more detailed information. Please use this table to fill out questions 1–3.

Sample data:

Case #	Age	Sex	Symptoms (Yes/No)	Time of onset of symptoms	School
1	16	F	Y	10/5/05	North High School
2	17	M	N	N/A	North High School
3	12	M	N	N/A	South High School
4	15	F	N	N/A	South High School
5	16	M	Y	10/4/05	North High School
6	17	M	Y	10/5/05	North High School
7	15	F	N	N/A	North High School
8	16	F	N	N/A	North High School

Not real data

1. **Please describe the data in terms of "person." How many people have the disease? How many males/females? What is the range of ages of people affected?**

2. **Please describe the data in terms of "place." Where were most people affected? Was everyone from the same town or school?**

3. **Please describe the data in terms of "time." When did this happen? What is the range of dates that people showed symptoms?**

4. **Epidemiologists use something called a 2x2 table to help them determine the risk of getting the disease if exposed. For this exercise, the health department was able to provide a more comprehensive number of people who did and did not have the disease. According to the health department records, there were 500 students in the school. One hundred of these students had eaten at the cafeteria, had had some sort of fruit or vegetable with their meal, and presented symptoms. Three hundred and fifty students had eaten at the cafeteria but did not have any fruit or vegetable, nor were any of these students sick. Twenty students had eaten at the cafeteria and were sick, but they had not eaten any fruits or vegetables. Please fill out the School Outbreak**

Table and calculate the relative risk to determine how likely students were to have the disease if they were exposed. What can you conclude from this number?

Sample Table:

	Had the disease	**Did not have the disease**	**Total**
Was exposed	A	B	A + B
Was not exposed	C	D	C + D
Total	A + C	B + D	A + B + C + D

Relative Risk: Tells us how likely someone is to have the disease if they are exposed.

Relative Risk = $\frac{A/(A + B)}{C/(C + D)}$

School Outbreak Table:

	Had the disease	**Did not have the disease**	**Total**
Was exposed			
Was not exposed			
Total			

Relative Risk =

Conclusion:

Data Collection Tool Answer Key

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The health department has provided a sample of the data with more detailed information. Please use this table to fill out questions 1–3.

Sample data:

Case #	Age	Sex	Symptoms (Yes/No)	Time of onset of symptoms	School
1	16	F	Y	10/5/05	North High School
2	17	M	N	N/A	North High School
3	12	M	N	N/A	South High School
4	15	F	N	N/A	South High School
5	16	M	Y	10/4/05	North High School
6	17	M	Y	10/5/05	North High School
7	15	F	N	N/A	North High School
8	16	F	N	N/A	North High School

Not real data

1. **Please describe the data in terms of "person." How many people have the disease? How many males/females? What is the range of ages of people affected?**

   A total of three people exhibited symptoms. There were two males and one female. Ages ranged from 12 to 17 for the entire population. Ages for those people who exhibited symptoms ranged from 16 to 17.

2. **Please describe the data in terms of "place." Where were most people affected? Was everyone from the same town or school?**

   There were six people from North High School and two from South High School. All of the people who exhibited symptoms went to North High School. None of the people from South High School exhibited symptoms.

3. **Please describe the data in terms of "time." When did this happen? What is the range of dates that people showed symptoms?**

   Two of the people who exhibited symptoms started on 10/5/05. One person had symptoms starting 10/4/05.

4. **Epidemiologists use something called a 2x2 table to help them determine the risk of getting the disease if exposed. For this exercise, the health department was able to provide a more comprehensive number of people who did and did not have the disease. According to the health department records, there were 500 students in the school. One hundred of these students had eaten at the cafeteria, had had some sort of fruit or vegetable with their meal, and presented symptoms. Three hundred and fifty**

students had eaten at the cafeteria but did not have any fruit or vegetable, nor were any of these students sick. Twenty students had eaten at the cafeteria and were sick, but they had not eaten any fruits or vegetables. Please fill out the School Outbreak Table and calculate the relative risk to determine how likely students were to have the disease if they were exposed. What can you conclude from this number?

Sample Table:

	Had the disease	**Did not have the disease**	**Total**
Was exposed	A	B	A + B
Was not exposed	C	D	C + D
Total	A + C	B + D	A + B + C + D

Relative Risk: Tells us how likely someone is to have the disease if they are exposed.

Relative Risk = $\frac{A/(A + B)}{C/(C + D)}$

School Outbreak Table:

	Had the disease	**Did not have the disease**	**Total**
Was exposed	100	30	130
Was not exposed	20	350	370
Total	120	380	500

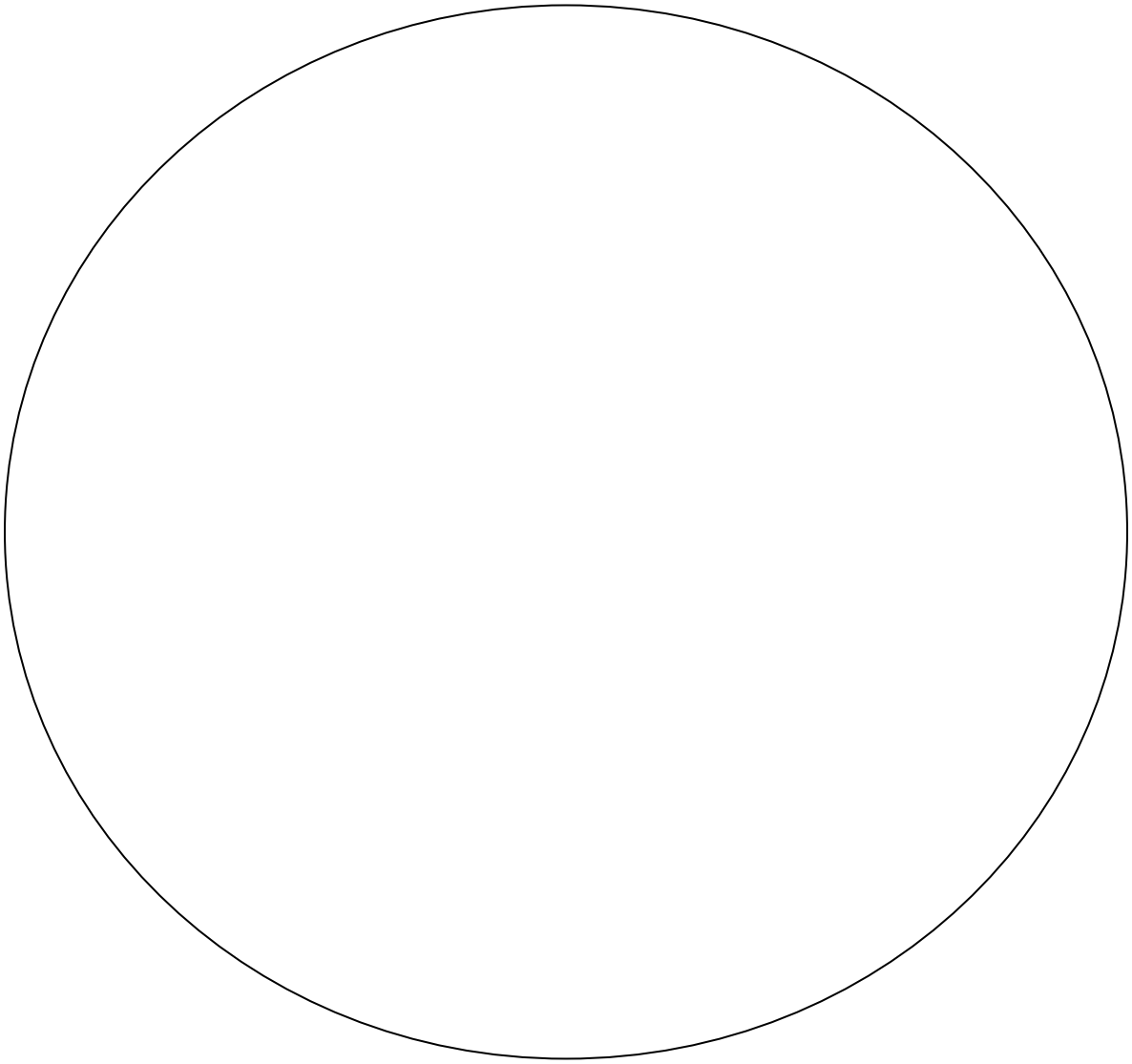
Relative Risk = $\frac{100/(100 + 30)}{20/(20 + 350)}$ = 0.77/0.054 = 14.3

Conclusion: This means that people who were exposed were 14.3 times as likely to get the disease as people who were not exposed.

G.O. S.H.A.R.E.: The Seven Characteristics of Life

Don't Drink the Water!: Investigating a Cholera Epidemic
Rebecca Johns, CDC's 2005 Science Ambassador Program

Directions: Use a ruler to divide the circle below into seven slices. On the outside of the circle, label each of the seven slices with one letter of "G.O. S.H.A.R.E." Also on the outside of the circle, fill in what each letter stands for. Choose one organism to draw and color in each slice of the wheel below. For example, in the "G" (growth and development) slice, draw and color a small rabbit then a larger rabbit. In the "O" (organized) slice, draw and color a rabbit's cells, tissues, and an organ like the heart.



Dr. Snow and the Scientific Method

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Read the following article then answer the questions below:
www.ph.ucla.edu/epi/snow/broadstreetpump.html

1. Explain how the scientific method was applied to Dr. Snow's experiment. Note: One thing written below was not done in this "natural experiment." Put a star by the step below that is a part of the scientific method, but that thankfully Dr. Snow did not include.

#1: Observation –

#2: Question –

#3: Hypothesis (If…then statement) –

#4: Design and Perform an Experiment (preferably quantitative) –

#5: Record Results (Data) –

#6: Repeat the Experiment –

#7: Conclusion –

#8: Publish the Results –

2. What was the independent variable in this experiment?

3. What was the dependent variable in this experiment?

4. Explain why some people who received water from Lambeth died from cholera.

5. Name two chemicals that have been added to drinking water in many nations since Snow's time that have made water safe to drink. (Hint: Think of what is added to pools and what is found in toothpaste).

Dr. Snow and the Scientific Method Key

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Read the following article then answer the questions below:
www.ph.ucla.edu/epi/snow/broadstreetpump.html

1. Explain how the scientific method was applied to Dr. Snow's experiment. Note: One thing written below was not done in this "natural experiment." Put a star by the number below that is a part of the scientific method, but that thankfully Dr. Snow did not include.

#1: Observation – Many people are dying from cholera.

#2: Question – How is cholera being transmitted?

#3: Hypothesis (If…then statement) – If the bacteria cholera is present in drinking water, then people who drink the water may become ill.

#4: Design and Perform an Experiment (preferably quantitative) – Compare houses that received water from two different companies to deaths from cholera.

#5: Record Results (Data) – Saw higher number of deaths from the Broad Street pump.

#6: Repeat the Experiment – *This step was not repeated.

#7: Conclusion – Water from the Broad Street pumo was contaminated with cholera. Those houses that received their water from the Broad Street pump were at a greater risk of becoming ill.

#8: Publish the Results – Dr. Snow shared the results with the community and published his findings.

2. What was the independent variable in this experiment?
Water sources

3. What was the dependent variable in this experiment?
Death of Londoners due to cholera

4. Explain why some people who received water from Lambeth died from cholera.
They may have come into contact with the water from the Broad Street pump in other ways.

5. Name two chemicals that have been added to drinking water in many nations since Snow's time that have made water safe to drink. (Hint: Think of what is added to pools and what is found in toothpaste).
Chlorine and Fluoride

Children of Thalidomide Posttest

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This worksheet is based on the "Children of Thalidomide" article available at http://science-education.nih.gov/nihHTML/ose/snapshots/multimedia/ritn/Thalidomide/index.html

1. Who were the "children of thalidomide" mentioned in Billy Joel's song?

2. Why did their mothers take the drug thalidomide early in their pregnancies?

3. How many of the 10,000 were born in the United States?

4. Why was this number so low in the U.S.?

5. Where and when was thalidomide developed?

6. Why did sales of this sleeping pill boom?

7. What U.S. administration must approve all drugs before they are sold in the U.S.?

8. Thalidomide was popular in Europe. Why then did Kelsey refuse to approve the sale of it in the U.S.?

9. Kelsey resisted pressure from manufacturers to approve thalidomide. It was a good thing she did. What happened in 1961?

10. What did the British physician speculate that thalidomide was damaging?

11. What did Kelsey then suspect that thalidomide may cause harm to?

12. When did a German doctor report that thalidomide did indeed cause birth defects and it was soon pulled from the market?

13. Why did a few American women give birth to "thalidomide babies"?

14. In 1962, which award did President Kennedy award to Kelsey for her 2-year battle with the makers of thalidomide?

15. In 1965, how was thalidomide used again?

16. How does thalidomide ease the discomfort of a person with leprosy?

17. What else is thalidomide being used to treat?

18. What type of patient should be using thalidomide?

19. Thalidomide may be beneficial for treating inflammation. What is inflammation?

20. What is arthritis?

21. What does thalidomide heal in people infected with HIV?

22. Thalidomide irreversibly damages nerves in the fingers and toes. What can this lead to problems with?

23. In the 1900s, a doctor in Paris treated a patient with a gold injection to try and treat tuberculosis. This didn't treat tuberculosis, but what did it help to do?

Children of Thalidomide Posttest Key

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1. What were the "children of thalidomide" mentioned in Billy Joel's song?
   The 10,000 babies born with shortened arms or legs or without any limbs at all.

2. Why did their mothers take the drug thalidomide early in their pregnancies?
   The mothers took the drug to sleep better and to reduce nausea.

3. How many of the 10,000 were born in the United States?
   Seventeen

4. Why was this number so low in the U.S.?
   Dr. Frances Kelsey blocked the sale of the drug in the U.S.

5. Where and when was thalidomide developed?
   In Germany in the 1950s

6. Why did sales of this sleeping pill boom?
   It was cheap, seemed safe even when taken in large quantities, and apparently caused no harm in experimental animals.

7. What U.S. administration must approve all drugs before they are sold in the U.S.?
   The Food and Drug Administration

8. Thalidomide was popular in Europe. Why then did Kelsey refuse to approve the sale of it in the U.S.?
   Too little information was known about its side effects. No harmful effects on animals, but also no beneficial effects (it did not make the animals sleepy).

9. Kelsey resisted pressure from manufacturers to approve thalidomide. It was a good thing she did. What happened in 1961?
   Kelsey read in the British Medical Journal that thalidomide could have harmful effects—tingling, numbness, and burning pain in the fingers and toes.

10. What did the British physician speculate that thalidomide was damaging?
    Nerves in the fingers and toes

11. What did Kelsey then suspect that thalidomide may cause harm to?
    A developing fetus

12. When did a German doctor report that thalidomide did indeed cause birth defects, leading to the drug being pulled from the market shortly afterwards?
    1961

13. Why did a few American women give birth to "thalidomide babies"?
    They were participating in investigational studies or had gotten it from other countries.

14. In 1962, which award did President Kennedy award to Kelsey for her 2-year battle with the makers of thalidomide?
    The Gold Medal for Distinguished Civilian Service

15. In 1965, how was thalidomide used again?
    To treat a patient with leprosy.

16. How does thalidomide ease the discomfort of a person with leprosy?
    It helps a patient sleep and brings the inflammation under control.

17. What else is thalidomide being used to treat?
    AIDS

18. What type of patient should be using thalidomide?
    A patient that has a serious, life-threatening, or unresponsive condition

19. Thalidomide may be beneficial for treating inflammation. What is inflammation?
    A painful condition in which tissues are damaged, get red and hot, and swell up

20. What is arthritis?
    An inflammation of the joints

21. What does thalidomide heal in people infected with HIV?
    Mouth and throat sores

22. Thalidomide irreversibly damages nerves in the fingers and toes. What can this lead to problems with?
    Muscle control, such as difficulty walking

23. In the 1900s a doctor in Paris treated a patient with a gold injection to try and treat tuberculosis. This didn't treat tuberculosis, but what did it help to do?
    The patient also had arthritis and the gold injections reduced the swelling and redness in the patient's joints and later became the standard treatment for arthritis.