The Hantavirus Haunting: Solving the Case

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

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Summary
This lesson is for a high school introductory biology class. Students will take part in a scientific investigation of a 1993 hantavirus outbreak and learn how to prevent hantavirus infection.

Learning Outcomes

- Students will be able to correctly sequence the events of an outbreak investigation, identify the disease, and describe the transmission of hantavirus.
- Students will be able to describe in writing hantavirus pulmonary syndrome, hantavirus transmission, and hantavirus prevention.
- With permission of the school administration, students will make observations of the school cafeteria and suggest prevention strategies for rodent control.

Materials

1. Set of hantavirus game cards for groups of students
2. "Solving the Case" worksheet for each group
3. A copy of the "Tracking a Mystery Disease: The Detailed Story of Hantavirus Pulmonary Syndrome" article from CDC website (http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/outbreak.htm) for each student
4. A copy of the "Seal Up, Trap Up, Clean Up" assignment with directions and rubric for each student

Total Duration
2 hours

Procedures

Teacher Preparation
You will be dividing the class into groups of four. Make enough copies of the "Disease Detective Cards" so that each group has a full set of the cards. Copying the cards onto cardstock might be helpful. Cut out the cards. Make copies of the "Solving the Case" worksheet for each group. Make copies for each student of the "Tracking a Mystery Disease: The Detailed Story of Hantavirus Pulmonary Syndrome" article and the "Seal Up! Trap Up! Clean Up!" assignment. Review "The Hantavirus Haunting: Solving the Case" Lecture Notes to become familiar with hantavirus. You can also review the "Hantavirus Pulmonary Syndrome: Teaching Slide Set" for more information on hantavirus pulmonary syndrome. In addition, get approval from the administration and cafeteria workers to do the "Seal Up! Trap Up! Clean Up!" activity.

Supplemental Documents
Title: Disease Detective Cards
Description: These cards provide clues about the hantavirus outbreak.

Title: Solving the Case Worksheet
Description: Worksheet for groups to record their answers to the questions posed about the 1993 hantavirus outbreak mystery case.

Title: The Hantavirus Haunting: Solving the Case Lecture Notes
Description: Lecture notes provide an outline including a general description of viruses, hantavirus pulmonary syndrome, and prevention measures.

Web Resources
Title: Tracking a Mystery Disease: The Detailed Story of Hantavirus Pulmonary Syndrome
URL: www.cdc.gov/ncidod/diseases/hanta/hps/noframes/outbreak.htm
Description: This article is from the Centers for Disease Control and Prevention, National Center for Infectious Diseases, Special Pathogens Branch. Click on the "All About Hantaviruses" section for more information and resources about hantaviruses.

Title: Hantavirus Pulmonary Syndrome: Teaching Slide Set
URL: www.cdc.gov/ncidod/diseases/hanta/hps/noframes/hpsslideset/index.htm
Description: This slide set is designed to teach medical and public health professionals about hantavirus pulmonary syndrome. It can help teachers prepare to implement this lesson in their classroom.

Introduction **Duration: 5 minutes**
Important! Do not tell students the title of this lesson or activity. Tell students that they are CDC scientists on special assignment to help identify the cause of a recent outbreak. Inform students that they will be working in teams of four. The first team who correctly identifies the sequence of events, the disease involved in the outbreak, and the method of transmission for the outbreak will receive a promotion.

Step 2 **Duration: 35 minutes**
Give each team a set of "Disease Detective Cards." Ask one member of each team to deal the cards to team members. Instruct students to take turns reading a clue to their group. Groups may use one pen and one piece of paper to write down pertinent information. After all the cards have been read, instruct each team to answer the questions on their "Solving the Case" worksheet. Each team will figure out the sequence of the disease outbreak in its own way. Tell the teams to bring their "Solving the Case" worksheet to you when they believe they have answered all the questions correctly.

Supplemental Documents
Title: Disease Detective Cards
Description: Clues for "The Hantavirus Haunting: Solving the Case" game to actively engage students in a social learning environment.

Title: Solving the Case Worksheet
Description: Worksheet for groups to record their answers to the questions posed about the outbreak.

Step 3 **Duration: 10 minutes**

When a team correctly identifies the sequence of events in the hantavirus case, identifies hantavirus as the infectious agent involved in the outbreak, and explains how hantavirus was transmitted in this case, award those students the CDC promotion. Allow the other groups to finish their worksheets and turn them in. When all groups are finished, ask a volunteer from the winning team to explain their scientific thought process and how they arrived at their conclusion. Have each group explain how they did their investigation.

Step 4 **Duration: 10 minutes**

To connect the activity with real-life events, give students the "Tracking a Mystery Disease: The Detailed Story of Hantavirus Pulmonary Syndrome" article to read. You may choose to have students read alone or in groups, or to read the article aloud as a class.

Web Resource
Title: "Tracking a Mystery Disease: The Detailed Story of Hantavirus Pulmonary Syndrome"
URL: www.cdc.gov/ncidod/diseases/hanta/hps/noframes/outbreak.htm
Description: This article is from the Special Pathogens Branch, National Center for Zoonotic, Vector-Borne, and Enteric Diseases of the Center for Disease Control and Prevention. The article describes the events of a real-life outbreak of hantavirus pulmonary syndrome in 1993. Click on the "All About Hantaviruses" section for more information and resources about hantaviruses.

Step 5 **Duration: 20 minutes**

Using "The Hantavirus Haunting: Solving the Case" lecture notes, lead a discussion about viruses in general, specifics about hantavirus infection and transmission, and ways to prevent the spread of hantavirus pulmonary syndrome with the "Seal Up! Trap Up! Clean Up!" campaign.

Supplemental Document
Title: The Hantavirus Haunting: Solving the Case Lecture Notes
Description: Lecture notes provide an outline about viruses, hantavirus pulmonary syndrome, and hantavirus prevention measures.

Web Resources
Title: What You Need to Know: CDC Hantaviruses
URL: www.cdc.gov/ncidod/diseases/hanta/hps/noframes/FAQ.htm
Description: This CDC website has information on the mode of transmission, reservoir, and other facts about hantaviruses.

Title: CDC Hantavirus Pulmonary Syndrome: Prevention Spotlight
URL: www.cdc.gov/rodents
Description: This CDC website has information on the "Seal Up! Trap Up! Clean Up!" campaign, aimed at preventing hantavirus pulmonary syndrome and other rodent-borne diseases.

Conclusion **Duration: 40 minutes**

Instruct students to use the information from the lecture about the "Seal Up! Trap Up! Clean Up!" campaign to inspect the school cafeteria and identify risks for potential rodent invasion. Students should work in their teams of four. After making a list of risks, have students work individually to write a letter to school officials about the importance of reducing rodent invasion, describing hantavirus prevention, and offering three detailed suggestions for safeguarding the school cafeteria.

Supplemental Document

Title: Seal Up! Trap Up! Clean Up! Project

Description: This worksheet guides students in inspecting the school cafeteria for risks of potential rodent invasion and in writing a letter to the school principal.

Assessment

Students will be assessed based on their completion of the "Solving the Case" worksheet in Steps 2 and 3 and on their letter to school officials in the conclusion.

Modifications

Extension(s)

Further investigate specific viruses and methods of transmission, replication, and prevention. Consider using the Science Ambassador lesson plan "West Nile Virus: What Is The Risk?" which uses a fictional West Nile Virus outbreak to teach math skills and some basic epidemiology. Go to www.cdc.gov/ncbddd/folicacid/ambassador_pgm/lessonplans_epi.htm.

Other Modifications

- Decrease or increase the game time.
- Group the students into peer groups that best fit needs.
- Group students with vision impairments with another student who will read their cards aloud for them.

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**

LIFE SCIENCE, CONTENT STANDARD C:
As a result of their activities in grades 9–12, all students should develop understanding of

- The cell
- Molecular basis of heredity
- Biological evolution
- **Interdependence of organisms**

- Matter, energy, and organization in living systems
- **Behavior of organisms**

State of Ohio Science Content Standards

LIFE SCIENCES, Grade 10:

Benchmark A: Explain that cells are the basic unit of structure and function of living organisms, that once life originated all cells come from pre-existing cells, and that there are a variety of cell types.

Indicator 1: Explain that living cells

a. are composed of a small number of key chemical elements (carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur)
b. are the basic unit of structure and function of all living things
c. come from pre-existing cells after life originated, and
d. are different from viruses

SCIENTIFIC INQUIRY, Grade 10:

Benchmark A: Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate, and communicate the results of these investigations.

Indicator 4: Draw conclusions from inquiries based on scientific knowledge and principles, the use of logic, and evidence (data) from investigations.

SCIENTIFIC INQUIRY, Grade 11:

Benchmark F: Explain how human choices today will affect the quality and quantity of life on earth.

Indicator 9: Give examples of how human activity can accelerate rates of natural change and can have unforeseen consequences.

Indicator 11: Investigate issues of environmental quality at local, regional, national, and global levels such as population growth, resource use, population distribution, over-consumption, the capacity of technology to solve problems, poverty, the role of economics, politics, and different ways humans view the earth.

Disease Detective Cards

The Hantavirus Haunting: Solving the Case
Jamie Valo and Sarah Wabler, CDC's 2006 Science Ambassador Program

Note to teachers: Print this document, then cut out the cards to form one complete set of "Disease Detective" cards for the class activity. Shuffle the cards so that clues do not appear in order. Make one set of cards for each group of four students.

In the southwestern United States, John Doe was rushed to a hospital with shortness of breath.	John Doe was taken to the hospital in May 1993.
John Doe was young and physically fit.	John Doe died shortly after being taken to the hospital.
John Doe's fiancée, Jane, also had shortness of breath.	Jane died a few days before John did.

State officials from the southwestern United States conducted an investigation following the deaths of John and Jane.	A state investigator discovered five young people who died as a result of acute respiratory failure.
The five identified people in the southwestern United States who died of acute respiratory failure were young and healthy.	Possible causes of death investigators considered include bubonic plague, herbicide poisoning, a new type of influenza, or hantavirus pulmonary syndrome (HPS).
The symptoms of bubonic plague might include sudden fever, chills, swollen lymph glands, muscular pain, severe headache, seizures, general ill feeling.	The symptoms of herbicide poisoning might include headache, fatigue, dizziness, loss of appetite, nausea, stomach cramps, diarrhea, blurred vision, excessive tearing, pinpoint pupils of the eye, excessive sweating and salivation, slowed heartbeat (fewer than 50/min.), rippling of surface muscles, difficulty walking, chest discomfort, muscle twitching, involuntary urination.
The symptoms of a new type of influenza might include fever, headache, tiredness, dry cough, sore throat, congested nose, muscle aches and stiffness, shortness of breath.	The symptoms of hantavirus pulmonary syndrome might include fever, chills, muscle aches, headache, general ill feeling, dry cough, increased respiratory rate, shortness of breath, respiratory failure.

CDC researchers joined the state officials' investigation of the infected area.	CDC researchers trapped as many species of rodents as possible in the southwestern United States.
CDC researchers trapped rodents in the southwestern United States from June 1993 to mid-August 1993.	CDC researchers did not want to cause alarm in the community by wearing protective masks or clothing when trapping the rodents around case patient's homes. They only wore special protective clothing when working with the rodents in field laboratories where they were out of the public's view.
Thirty percent of one species of mouse, the deer mouse, was infected with a certain virus. Other types of rodents were infected with this virus as well.	The deer mouse (*Peromyscus maniculatus*) is the main host of the new type of disease.
CDC researchers conducted an investigation of the homes in the area. They investigated "case" households (households with a person who became ill) and "control" households (households where no one had gotten sick).	Case households were more likely than control households to have signs of rodent infestations, such as droppings or rodent nesting materials.

CDC researchers trapped more rodents in case households than in control households.	The disease that caused shortness of breath is transmitted to people by rodents.

Solving the Case

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Instructions: fill out this worksheet as you work with your group to solve the case.
Name:
Group:

1. What disease caused these deaths?

2. What evidence supports this claim?

3. How did this disease spread?

4. Outline the sequence of events in this investigation.

Solving the Case: Answer Key

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1. What disease caused these deaths?
   Hantavirus pulmonary syndrome (HPS), caused by hantavirus infection.

2. What evidence supports this claim?
   Both John and Jane had shortness of breath, a symptom of HPS.
   Hantavirus infection is transmitted by rodents, including deer mice.
   Rodents in the area showed evidence of hantavirus infection.
   Case households had greater exposure to rodents because researchers trapped more rodents in case households than in control households, and because people in case households did more planting in outdoor fields and cleaning around the house (which could stir up particles from rodent droppings and urine) than people in control households.

3. How did this disease spread?
   In this case, hantavirus is transmitted from rodents (deer mice) to humans. The case patients either inhaled aerosolized hantavirus in contaminated urine or feces or came into contact with an infected deer mouse.

4. Outline the sequence of events in this investigation.
   Two people, John and Jane, die from acute respiratory failure in May 1993.
   State officials start the investigation in southwestern United States.
   A state official discovers that five people died from similar causes.
   CDC researchers join in investigation and begin trapping rodents across the southwestern United States.
   CDC researchers find that 30% of one species of mouse, the deer mouse, was infected with a certain virus. Other types of rodents were infected with this virus as well.
   CDC researchers conduct a case-control study and trap more rodents in case households than in control households. Researchers also find that people in case households were more likely to be involved in activities that stir dust into the air than people in control households.
   Tests of local deer mice populations show hantavirus infections.
   CDC links the disease to hantavirus carried by deer mice.

"The Hantavirus Haunting: Solving the Case" Lecture Notes

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I) Virus Review

A) Review characteristics of viruses. Use discretion to emphasize important concepts discussed in class.

II) Hantaviruses

A) The hantaviruses are a group of viruses, some of which cause hantavirus pulmonary syndrome (HPS)
   1) The virus responsible for the outbreak discussed in class was a hantavirus called Sin Nombre virus

B) Hantavirus Pulmonary Syndrome
   1) Symptoms: The CDC hantavirus website lists some early symptoms as fatigue, fever and muscle aches, especially in the large muscle groups—thighs, hips, back, and sometimes shoulders. These symptoms are universal. There may also be headaches; dizziness; chills; and abdominal problems, such as nausea, vomiting, diarrhea, and abdominal pain. About half of all HPS patients experience these symptoms. Later symptoms include coughing and shortness of breath, with the sensation of, as one survivor put it, a "...tight band around my chest and a pillow over my face" as the lungs fill with fluid. http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/symptoms.htm

C) Transmission of hantaviruses
   1) Between rodents
      (a) Bites
      (b) Urine, feces
      (c) Saliva
   2) From rodents to humans
      (a) Aerosolized urine
      (b) Bites
      (c) Direct contact of mucous membranes or broken skin with infectious material
   3) Connection to southwestern United States: Why did the outbreak occur in the Four Corners region?
      (i) The Four Corners region had been in a drought for several years.
      (ii) In early 1993, heavy snows and rainfall helped drought-stricken plants and animals to revive and grow in larger-than-usual numbers. The area's deer mice had plenty to eat, and as a result, they reproduced so rapidly that there were 10 times more mice in May 1993 than there had been in May of 1992.
      (iii) With so many mice, it was more likely that mice and humans would come into contact with one another, and thus more likely that the hantavirus carried by the mice would be transmitted to humans.
   4) There is no cure for HPS, only treatments to reduce symptoms

III) Prevention

A) Seal Up!
  1) Rodents can squeeze through holes the size of their heads
    (a) Mice can fit through holes the size of a nickel
    (b) Rats can fit through holes the size of a half-dollar
  2) Materials for sealing up
    (a) Steel wool for small holes
    (b) Caulk for sealing cracks and holes stuffed with steel wool
    (c) Concrete for larger openings
    (d) Sheet metal for larger openings
  3) If openings are not sealed, rodents keep coming in

B) Trap Up!
  1) Snap trap
    (a) Use a pea-size amount of peanut butter
    (b) Place along wall
  2) Avoid glue traps or live traps
    (a) Rodents urinate when scared
    (b) These traps may increase risk of disease exposure

C) Clean up!
  1) Get rid of food sources
    (a) Store food in thick, sealed plastic containers
    (b) Do not leave pet food or water bowl out during night
    (c) Keep bird feeders away from house
    (d) Use thick plastic or metal garbage cans with tight lids
  2) Get rid of nesting sites
    (a) Move hay, woodpiles, and garbage cans at least 100 feet from house
  3) Carefully clean up droppings
    (a) Air out the area for 30 minutes
    (b) Use rubber gloves
    (c) Wet area with droppings well with a household disinfectant or bleach and water, then pick up with a paper towel and throw away
    (d) Do not sweep up droppings as this may create aerosols

References

1. Seal Up! Trap Up! Clean Up! campaign: www.cdc.gov/rodents
2. Hantavirus FAQ: http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/FAQ.htm
3. Hantavirus brochure: http://www.cdc.gov/ncidod/dvrd/spb/mnpages/HPS_Brochure.pdf
4. "How is hantavirus transmitted?" http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/transmit.htm
5. "Tracking a Mystery Disease: The Detailed Story of Hantavirus Pulmonary Syndrome" http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/outbreak.htm.

Seal Up! Trap Up! Clean Up! Project

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Part I:
In teams of four, spend 20 minutes in the school cafeteria assessing the risk for rodent invasion. Make observations about food storage, trash disposal, various openings in the walls, etc. Remember, "Seal Up! Trap Up! Clean Up!"

Record at least five observations below:

Part II:
Working individually, write a letter to the local school principal about your team's observations. Include a description of a hantavirus (symptoms and risk of infection), methods of transmission, and specific strategies to help the school prevent a hantavirus outbreak.

Rubric:

	Excellent (10 pts.)	Satisfactory (5 pts.)	Poor (2 pts.)
Symptoms, risk, and transmission of hantavirus	All three are included in detail.	Two out of three are included.	One out of three is included.
Prevention	Three strategies are included in detail.	Two strategies are included.	One strategy is included.
Format and Grammar	Correct letter format and no grammatical errors.	Correct letter format and fewer than two grammatical errors.	Incorrect letter format OR More than two grammatical errors.