NOVA

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The Most Dangerous Woman in America

PROGRAM OVERVIEW

NOVA tells the story of the life and struggles of Mary Mallon—the first healthy carrier of typhoid fever ever identified—and reviews the development of the nation's early public health policies as well as the question of individual versus societal rights.

The program:

- reviews the symptoms, virulence, transmission, and cause of typhoid fever.
- reveals the discovery in 1907 that people who had recovered from typhoid fever could still transfer the bacteria—they could be "healthy carriers" of the disease.
- relates how epidemiologist George Soper tracked down and first contacted Mallon, an Irish immigrant who had infected six of the eight families she had worked for over a ten-year period.
- portrays Mallon's fierce resistance to voluntary testing, her eventual arrest, and the forced testing that revealed she was carrying typhoid bacteria.
- contrasts Mallon's working-class world with that of the more educated public health officials who pursued her and speculates how those differences may have affected how Mallon was viewed.
- chronicles the evolution of New York public health policies that attempted to stem such diseases as typhoid fever, cholera, scarlet fever, and tuberculosis.
- reviews Mallon's quarantine at Riverside Hospital on North Brother Island, the use of experimental medicines on her while she was there, and her failed legal bid to win freedom from the island.
- relates Mallon's 1910 release by New York public health officials and her subsequent failure to keep her promise never to work again as a cook.
- follows Mallon's reconfinement to North Brother Island and her eventual acceptance of her life there, where she remained until her death in 1938 at age 69.

BEFORE WATCHING

1 Review the following terms with your students (see Activity Answer on page 4 for definitions): bacteria, contagious, epidemiology, infectious, and quarantine.

2 Organize the class into four groups and have each group take notes on one of the following points of view presented in the program: public health officials, Mary Mallon, families whose members contracted typhoid fever from Mallon, and the general public.

AFTER WATCHING

1 Have each group reflect on the outlook presented by the person or group it followed in the program. Then have each group recount a short summary of the point of view and the group's opinion about that point of view. Ask the class to discuss how the groups' views differ. What points do the students agree with? Disagree with? Why?

2 Mary Mallon was confined because as a healthy carrier of typhoid she could transmit the disease to others, yet she continued to work in a job in which transmission was likely. Did public health officials make the right decision when they removed her from her job? Why or why not? What are the rights and responsibilities of an individual who can transmit a disease? What are the rights and responsibilities of the society in which the individual lives?

3 Have students research school health policies. What are the guidelines for dealing with a range of contagious diseases or an epidemic? What do students think about existing policies? Have students defend their reasoning.

CLASSROOM ACTIVITY

Objective

To test the efficacy of different types of hand hygiene.

Materials for teacher

- 2 14.5 oz. cans of sliced beets (10–12 slices per can)
- can opener
- 1 pair new plastic gloves
- plastic forceps or tongs
- isopropyl alcohol (for disinfecting)

Materials for each team

- copy of the "Which Wash Wins?" student handout
- copy of the "Hand-Washing Methods" student handout
- 3 100 mm x 15 mm sterile plastic Petri dishes
- cotton swabs
- tape
- permanent marker
- access to sink with water (Teams 1, 2, and 3 only)
- regular soap (Team 2 only)
- antibacterial soap (with antiseptic like triclosan) (Team 3 only)
- hand sanitizer (with ethyl or isopropyl alcohol) (Team 4 only)
- paper towels (Teams 1, 2, and 3 only)

Procedure

1. Mary Mallon was a healthy carrier of the typhoid bacteria. Because she was a cook and handled food, she transmitted the disease to some of the people she worked for. Hand washing is one way to help stem the transmission of disease. In this activity students will test the efficacy of different types of hand hygiene.
2. Prior to the activity, thoroughly disinfect the tongs by spraying or soaking them in alcohol (you may want to wash the can opener and tongs in a dishwasher and store them in a plastic bag prior to disinfecting). (Note: To increase the sterility of the experiment, consider using sterile agar plates instead of the beets.)
3. Ask students if they have ever seen a sign in a restaurant bathroom that read: "Employees must wash hands." Why do students think these signs are there?
4. Ask students what they think would be the best way to keep hands clean. What kinds of products, if any, do they think would be best? What water temperature? What amount of time spent washing? Write students' answers on the board.

STANDARDS CONNECTIONS

The "Which Wash Wins?" activity aligns with the following National Science Education Standards.

GRADES 5–8
Science Standard F:
Science in Personal and Social Perspectives
Risks and benefits

- Individuals can use a systematic approach to thinking critically about risks and benefits. Examples include applying probability estimates to risks and comparing them to esti mated personal and social benefits.
- Important personal and social decisions are made based on perceptions of benefits and risks.

GRADES 9–12
Science Standard F:
Science in Personal and Social Perspectives
Personal and community health

- The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease-producing organism. Many diseases can be prevented, controlled, or cured. Some diseases, such as cancer, result from specific body dysfunctions and cannot be transmitted.

Video is not required for this activity.

Classroom Activity Author
Developed by WGBH Educational Outreach staff.

CLASSROOM ACTIVITY (CONT.)

5 Tell students that they are going to test four methods (a fifth group will serve as the control) of hand hygiene (you may want to adapt these methods to reflect students' suggestions): 1) water only, 2) regular soap, 3) antibacterial soap, and 4) hand sanitizer.

6 Organize students into five teams of four students each and provide each team with a set of materials. Each team will be assigned one of the following variables:

Control Team: no washing method
Experimental Team 1: washing with water only
Experimental Team 2: washing with regular soap and water
Experimental Team 3: washing with antibacterial soap and water
Experimental Team 4: washing with hand sanitizer only

7 Have each team develop a hypothesis of which of the four methods it thinks will work best and why. Then have students conduct the experiment as outlined in their handouts. As students start their hand-washing techniques, put on the plastic gloves and open the two cans of beets. Have each team use the tongs to retrieve three beet slices, one for each of the team's three Petri dishes. You may want to disinfect the tongs with alcohol between team uses.

8 Have students record the results in a journal each day, making sure to include diagrams. After four days, compare the growth on the beets from the different teams. As a class, answer the following questions:

- How did each set of beets compare to the control team's beets?
- Which experimental team's beets had the least bacteria?
- What areas (palms, in between fingers, under nails) were washed the most thoroughly by each technique? What areas were washed the least thoroughly?
- Was there any growth on the control beets?

9 Discuss the results with students. What results were most surprising? It's likely that all the beets showed some microbial growth because the experiment was not completely sterile. Discuss with students where microorganisms might have come from (beet, plastic tongs, cotton swab, Petri dish, tap water, air). How could the experiment have been made more sterile?

10 To conclude, discuss with students why and when it is appropriate to wash hands.

11 As an extension, have students research the controversy about whether using antibacterial soaps encourages the growth of new bacteria that are resistant to these products.

BEET DISPOSAL

The beets used in this experiment should just contain normal molds and bacteria. The beet slices can remain in their Petri dishes and be disposed of in the regular trash. Spray with a disinfectant, such as Clorox, prior to disposing. Make sure students do not touch the beets after sealing their Petri dishes.

ACTIVITY ANSWER

You may want to review the following terms with students:

bacteria: microscopic, single-celled organisms that can be helpful or harmful to the human body
contagious: able to be transmitted to others, through direct or indirect contact
epidemiology: branch of medicine that studies the causes, distribution, and control of diseases in populations
infectious: capable of causing an infection
quarantine: enforced isolation or restriction of a person or persons to slow or halt the spread of a contagious disease

An individual can have an infection yet not be contagious. For more information on contagious diseases, including incubation and contagious periods for specific diseases, see www.childrenshospitaloakland.org/health_library/pa/hhg/incubate.htm

Molds and some kinds of bacteria are most likely to grow on the beets. The molds will probably look fuzzy green or white while the bacteria may be one of several colors (such as pink, yellow, or brown) or colorless and look shiny or dull. The bacteria are likely to grow in lawns (individual colonies that merge together to form a mat of bacteria). The beet provides the nutrients and water the bacteria and molds need to grow.

The growth on the beets provides evidence that microorganisms can be transmitted by hands. One strength of that evidence is that all of the control beets likely showed growth while the beets for the teams that used antibacterial soap and hand sanitizer likely showed less growth. One weakness is that the experiment was not entirely sterile; bacteria and mold from several sources could have contaminated the beets.

According to the Centers for Disease Control (CDC), plain soap is good at reducing bacterial counts, antibacterial soap is better, and an alcohol-based handrub is the best. However, students' results may vary depending on how well they washed their hands with each type of cleaner. You may want to repeat the experiment with students and have them wash their hands for a full minute and compare results of both trials.

Remind students that while their hands contain many harmless bacteria, they can also transmit bacteria and viruses that can cause illness. According to the Centers for Disease Control, one of the most important steps individuals can take to keep from getting sick is to wash their hands.

Both alcohol-based sanitizers and antibacterial soaps can kill harmful bacteria, such as streptococcus, salmonella, and E. coli, but do not claim to kill viruses (although some viruses are susceptible to these cleansers). Sanitizers work by using alcohol to kill the bacteria (they usually contain 60% to 95% ethanol or isopropanol). Antibacterial soaps rely on an antiseptic agent, such as triclosan, to kill the bacteria. Regular soap, which can remove bacteria through the action of its bubbles, is not designed to kill bacteria or viruses.

Hands should be washed at the following times: before, during, and after preparing food; before eating; after using the bathroom; after exposure to animals or animal waste; after handling garbage; after coughing, sneezing, or blowing your nose; and if you are sick or have been around a sick person.

Because bacteria can be transmitted to food, it is especially important that people involved with food preparation (as Mary Mallon was) frequently and properly wash their hands so they do not spread disease by fecal-oral transmission. For a full list of when food employees are supposed to wash, see vm.cfsan.fda.gov/~dms/fc-2.html#2-3

LINKS AND BOOKS

Links

NOVA Web Site—The Most Dangerous Woman in America
www.pbs.org/nova/typhoid/
Find articles, interviews, interactive activities, and resources in this companion Web site to the program.

The Living City
156.145.78.54/htm/home.htm
Reviews in time line format the life, health, and urban transformation of New York City during the decades between the end of the Civil War and the end of World War I.

Stalking the Mysterious Microbe
www.microbe.org/
Provides background information on microbes and experiments.

Typhoid Mary
history1900s.about.com/library/weekly/aa062900a.htm
Reviews the story of Mary Mallon and provides links to additional information about typhoid fever.

What Should Be Done About Mary Mallon
www.learner.org/channel/workshops/primarysources/disease/activities01.html
Includes discussion questions related to Mary Mallon's case and provides access to related primary source documents.

Books

Baker, S. Josephine.
Fighting for Life.
New York, Arno Press, 1974 [c1939].
Provides an autobiographical look at the life and work of S. Josephine Baker, one of the first public health officers who approached Mary Mallon.

Bourdain, Anthony.
Typhoid Mary: An Urban Historical.
New York: Bloomsbury Publishing, 2003.
Reveals the context in which Mary Mallon lived and the obstacles she faced as an Irish woman immigrant.

Diner, Hasia R.
Erin's Daughters in America: Irish Immigrant Women in the Nineteenth Century.
Baltimore: Johns Hopkins University Press, 1983.
Portrays the story of a group of Irish immigrant women who overcome barriers of poverty, ignorance, and disease to succeed in America.

Hammonds, Evelynn Maxine.
Childhood's Deadly Scourge: The Campaign to Control Diphtheria in New York City, 1880-1930.
Baltimore: Johns Hopkins University Press, 1999.
Explains how New York City became the first U.S. city to apply laboratory-based advances in bacteriology and immunology to the treatment and prevention of diphtheria.

Kraut, Alan M.
Silent Travelers: Germs, Genes, and the "Immigrant Menace."
New York: Basic Books, 1994.
Covers immigration and health from a historical perspective, and includes accounts of how immigration and public health policies have influenced each other in the American experience.

Walzer Leavitt, Judith.
Typhoid Mary: Captive to the Public's Health.
Boston: Beacon Press, 1996.
Explains the science of germ theory and explores the conflicting perspectives of the players in Mary Mallon's story, including journalists, public health officials, the law, and Mary herself. NOVA's "The Most Dangerous Woman in America" was based on this book.

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Which Wash Wins?

How many times has someone told you: "Go wash your hands before dinner"? Why is hand washing important? Find out in this activity and discover which hand-washing method is the hands-down winner.

Procedure

1 You will be assigned to one of the following teams:
   Control Team: No washing.
   Experimental Team 1: water only
   Experimental Team 2: water and regular soap
   Experimental Team 3: water and antibacterial soap
   Experimental Team 4: hand sanitizer only
2 Organize your team so that there is a hand washer, a hand washer helper, a timer, and a data recorder.
3 Prior to starting, the data recorder should label the underside of each Petri dish with your team's information (control, 1, 2, 3, 4) and the location of each swab (palm, between fingers, fingernails).
4 The hand washer should wash his or her hands according to the procedure listed for your team on the "Hand-Washing Methods" handout. The hand washer should not touch anything after washing.
5 You are now ready to swab the hand washer's hands. Ask your teacher for the beets, and then:
   - Have one team member open the three Petri dishes. Have a second team member use the tongs to retrieve and place a beet in each dish. Replace the lids on all the dishes except for the one labeled "palm."
   - Using one end of the cotton swab, a third team member should swab the hand washer's palm and then swab one half of the beet slice. Repeat the procedure using the other end of the swab and rubbing the swab on the other half of the beet slice.
   - Place the lid back on the Petri dish and tape down two sides of the dish.
6 Repeat this process for the beets in the other two Petri dishes using a swab from between the hand washer's fingers for one slice and a swab from under the fingernails for the other slice.
7 Put your beets in a place where they will not be disturbed. Record daily observations of the beet for five days, describing the different kinds of growths you see. Draw a picture of what you see each day.

Questions

Write your answers on a separate sheet of paper.

1 After four days, compare your beets with those of the other teams. Which ones have the most growth?
2 Draw conclusions about the efficacy of your hand-washing method based on each team's results. What evidence do you have that microorganisms can be transmitted by hands? What are the strengths and weaknesses of that evidence?
3 What other factors might be responsible for the growth?
4 Based on your results, why would you want to wash your hands? When would you want to wash them?
5 What are some diseases that might be transmitted by hand contact?
6 Why is it important that food service employees wash their hands?

Hand-Washing Methods

Follow the method listed for your team.

Control Team: No hand washing.

Experimental Team 1: Turn on cold water. Hand washer should rub hands together under running water for 15 seconds, making sure to wash the palms, fingers, and under the fingernails. Hand washer helper should turn the water off. Hand washer should then dry hands with a clean paper towel. Hand washer should not touch anything after washing.

Experimental Team 2: Wet hands with cold water. Apply enough regular soap to form a lather. Rub hands together (without the water) for 15 seconds, making sure to wash the palms, fingers, and under the fingernails. Rinse hands. Hand washer helper should turn the water off. Hand washer should then dry hands with a clean paper towel. Hand washer should not touch anything after washing.

Experimental Team 3: Wet hands with cold water. Apply enough antibacterial soap to form a lather. Rub hands together (without the water) for 15 seconds, making sure to wash the palms, fingers, and under the fingernails. Rinse hands. Hand washer helper should turn the water off. Hand washer should then dry hands with a clean paper towel. Hand washer should not touch anything after washing.

Experimental Team 4: Hand washer should use the recommended amount of hand sanitizer and rub hands together until they are completely dry, making sure to wash the palms, fingers, and under the fingernails. Hand washer should not touch anything after washing.