

SIMULATING THE SPREAD OF AN INFECTIOUS DISEASE

Introduction

From bubonic plague to AIDS to the Guinea worm parasite, scientists and public health officials have struggled to understand and contain the spread of infectious diseases. Using simple reagents, participants will simulate the spread of a simple imaginary disease in order to explore some factors that affect the rate of infection, the challenges of epidemiology, and measures which can help prevent the spread of disease. Following the activity, participants will tour the *Infectious Disease: Evolving Challenges to Human Health* exhibit and explore the challenges we face and the available options for halting the spread of disease.

Simulating an Epidemic

Materials:

- Test tube and dropper for each participant
 - Test tube lids
 - Distilled water
 - 0.1 molar NaOH
 - pH 7.0 buffer solution
 - Phenolphthalein solution, dissolved in alcohol and diluted in water (pH indicator)
1. Let participants know they are going to model the transmission of a disease by exchanging some of their test tube's contents with that of other participants. Mention that one of the test tubes is "infected" with an imaginary infectious disease. (Prepare the test tubes prior to the activity: Fill one tube halfway with 0.1 molar NaOH and one with the buffer solution; fill the rest of the tubes halfway with distilled water.)
 2. Distribute prepared test tubes and droppers randomly to the class. Make a mental note of who receives the test tube containing NaOH. Keep the test tube with the buffer solution.
 3. Have participants walk around the room with their test tubes. When you say "Stop!", each participant should use a dropper to trade a drop of fluid with the person nearest them. Repeat until at least three trades have occurred.
 4. Now it's time to test for the imaginary infection. Put a drop of phenolphthalein in each test tube. If the fluid turns pink, the cup is "infected" with NaOH. How many participants are now "infected"?

CAUTION: Sodium hydroxide (NaOH) and phenolphthalein can irritate the eyes and skin. Alert participants to avoid spilling and warn them to NEVER drink what is in the test tube.

Tracing the Source of Infection

1. Now that a portion of the group has been "infected," put participants in the role of epidemiologists. Their challenge is to collect data that will help them trace the path of the epidemic and locate the original carriers.
2. As a group, use the data to try to deduce which individual was the original carrier of the disease. Why might it be important to locate the source of infection? What difficulties arise in trying to collect and interpret data? Note that the simulated disease has a 100% rate of infection that appears immediately under testing. Some infections, such as AIDS and chicken pox, can remain dormant in the body for a long time. Others, such as Ebola, kill the host rapidly. How might each of these factors affect the spread of disease and the ability to identify carriers?

If you have a large group (35 or more) you may want to begin with two test tubes containing NaOH.

The final number of "infected" test tubes will vary depending on (1) the number of trades and (2) how many trades occur between two already infected tubes.

A possible method to find "patient zero" is to have each participant write his or her name on the board and underneath it the names of participants with whom he or she exchanged fluids in the order in which the exchanges occurred. Then, as a group, highlight the names of the currently "infected" people (shown in bold in sample).

This visual representation can help clarify which participants may have infected one another, and in what order. Participants who "test positive" and find that everyone with whom they traded also tested positive may be original carriers of the disease (Cal, Dee, Gib, and Hal in this example). It is likely that there will be several candidates for "patient zero." Cross-checking the history of each contact can narrow the field, but probably not to less than two candidates. (For example, here, Cal and Dee can be eliminated as "patient zero" because their first contacts, Bob and Ed, did not infect their own second contacts, Fran and Ilsa; either Gib or Hal, however, could be "patient zero.") If participants are unable to reach a clear conclusion, the exercise will raise useful questions about the challenges facing real epidemiologists as they try to trace the sources of an infection.

Sample Chart Tracing Infection

	Ann	Bob	Cal	Dee	Ed	Fran	Gib	Hal	etc.
Exchange 1	Fran	Cal	Bob	Ed	Dee	Ann	Hal	Gib	
Exchange 2	Jo	Fran	Gib	Hal	Ilsa	Bob	Cal	Dee	
Exchange 3	Gib	Dee	Ed	Bob	Cal	Jo	Ann	Lin	

Measures for Preventing the Spread of Disease

Rapid and constant evolution challenges our main defenses against infectious diseases, which include

- *public health measures* that minimize exposure to disease-causing organisms;
- *immunity*, whether gained by infection or vaccination; and
- *therapeutic drugs* used to treat infections.

Demonstrating how we can prevent the spread of disease using this activity will help museum visitors as they explore the *Infectious Disease: Evolving Challenges to Human Health* exhibit.

Public health measures – Minimizing or eliminating exposure to disease agents through public health measures can greatly diminish the impact of a disease outbreak. Ask participants how they would minimize exposure to the liquid from another people. Two ways to illustrate public health measures are: 1) Put a cap on your test tube, and 2) Isolate yourself so that you are not near anyone else. The cap represents measures such as bed nets or condoms, which prevent exposure to disease causing agents. Isolating yourself is the same as a quarantine, which is often used to isolate disease carrying individuals during an outbreak.

Immunity – Vaccines provide immunity for an individual against a disease, even after exposure. Vaccines featured in the exhibit include smallpox, polio, tetanus, hepatitis B, influenza, and measles. Using the test tube with the buffer solution, add a couple of drops of the phenolphthalein indicator, followed by a couple of drops of the NaOH solution. While there might be a quick flash of pink when the drops of NaOH hit the test tube solution, the color should quickly return to clear. The buffer is acting to neutralize (figuratively and literally) the NaOH/disease.

Therapeutic drugs – Drugs can be an effective means for treating a disease after exposure. Therapeutic drugs featured in the exhibit include antibiotics, anti-malarial drugs, and anti-retroviral drugs for HIV/AIDS. Drugs can be effective in preventing the spread of disease by eliminating the pathogen from the body, or by preventing the agent from functioning properly. For this activity, take a test tube that has tested positive by turning pink and add a few drops of the buffer. In this case, the buffer will neutralize the solution and turn the color back to clear, thus eliminating the infection.

Source: This activity is based in part on an activity presented at www.pbs.org/wgbh/aso/resources/guide/medact4index.html.