Unit 4: Prevention
Activity 2: The Impact of Vaccines

Description:
Students will participate in an interactive game that demonstrates how vaccination and immunization slows the spread of disease.

Time:
Game: 30-45 minutes
Discussion/Questions: 15-20 minutes

Objectives:
- To learn how the spread of disease often occurs exponentially;
- To understand the impact that vaccination programs have on the spread of disease
- To interact creatively with one's peers.

Curriculum Links:
This activity is meant to allow students to be introduced to ideas of prevention of disease and the rate at which it spreads.

Science and Technology – Understanding Life Systems	1. Relating Science and Technology to Society and the Environment	1.1 assess the effects of social and environmental factors on human health, and propose ways in which individuals can reduce the harmful effects of these factors and take advantage of those that are beneficial
		1.2 evaluate the effects, both beneficial and harmful, of various technologies on human body systems, taking different perspectives into account
The Arts – B. Drama *(for optional PSA activity)*	B1. Creating and Presenting	B1.1 engage actively in drama exploration and role play, with a focus on examining issues and themes in fiction and non-fiction sources from diverse communities, times, and places *(e.g., use role play to explore social issues)*

Materials: n/a

Procedure:

1. Lead students through the activity.
2. As a class, discuss the spread of disease (or get them to write a written response about the game) and how vaccines help prevent them.
   Prompts: What did the addition of the vaccine do to the numbers of those affected with disease in the game? How did the numbers of those infected compare to those who were vaccinated? What does this tell us about the spread of disease?

Game Instructions:
This game is based on Wink Murder, with modifications to reflect how vaccinations affect disease transmission.
Roles: a) Disease – passed on by winking
b) Vaccine – passed on by secret handshake
c) Epidemiologist – who seeks to identify the main cause of the outbreak

1. ROUND ONE: DEMO
   a. The teacher chooses one person to play the role of the Disease and lets that person know their role, but keeps it a secret from the rest of the class.
   b. Students will then walk around the class and shake hands with everyone. If, while shaking hands, the Disease winks at you, you have contracted the disease. After you have shaken hands with one more person (to mimic an incubation period) you also take on the role of disease and can begin to wink at others.
   c. Play for 30-60s. See how fast disease spreads with no controls in place.

2. ROUND TWO: DISEASE AND VACCINE
   a. The teacher quietly chooses 2 students: one who is “The Disease,” and one who is “The Vaccine”.
   b. The same rules apply for those who get winked at by the disease as in Round One, unless you have been previously vaccinated. You have been vaccinated if you have received the secret handshake from The Vaccine. Only the designated Vaccine can give the handshake.
   c. After 30-60s seconds stop the game and assess who has been infected and who is vaccinated. Compare these numbers to those in Round One. How is the vaccine affecting the spread of disease?

3. ROUND THREE: DISEASE, VACCINE AND EPIDEMIOLOGIST
   a. Three students are chosen to take on the roles of The Disease, The Vaccine, or The Detective.
   b. Play the game as per Round Two, with the following modifications:
      - If you have been infected and are now transmitting the Disease, and subsequently shake hands with another player also transmitting the Disease, then you must silently count to 5 and then act out a dramatic death.
   - The Epidemiologist wanders around the room, not shaking hands with their classmates. They are attempting to identify the original source of the

Disease. They have three guesses to identify the Disease. If they incorrectly select the Vaccine, then the Disease wins.

Background Information

- *Vaccination:*
  - Robert Koch – Tuberculin

At the 10th International Congress of Medicine in Berlin in 1890, Robert Koch announced that he had found a substance that would protect against tuberculosis – tuberculin. The medical community reacted with mixed results. Koch's renown for his discovery of the tuberculosis bacteria in 1882 gave him credence with many, yet many others reserved judgement because Koch refused to identify the material used in tuberculin until 1891. It was then revealed that tuberculin is an attenuated mixture dead bacteria, as well as of proteins and antigens found in the fluid in which Mycobacterium tuberculosis had been grown. Tuberculin was administered through a subcutaneous injection. Many recipients of the vaccine had strong negative reactions, however, and the medical community quickly came to see the benefits of tuberculin not as a vaccine, but as diagnostic test.

The tuberculin skin test involves injecting a small amount of tuberculin under the skin and observing whether there is immune response, such as swelling and blistering, which indicates that the body has been in contact with the substance before, that the individual has been infected with tuberculosis.

In Canada, by the 1920s tuberculin skin tests were being used as part of mass screenings of communities to test for tuberculosis. In 1921 the Saskatchewan Anti-Tuberculosis Commission tested 1700 school children, revealing that 44% had been infected with tuberculosis by age 6, that 60% were infected by age 14, and that 76% were infected by age 18, but that only 0.84% had active tuberculosis. Additional tests, such as x-ray screenings, were also used to further identify active cases.

Tuberculin skin tests continue to be the most commonly used diagnostic tool for tuberculosis.

  - Albert Calmette and Camille Guérin – BCG Vaccine

The first successful vaccine against tuberculosis was developed at the Pasteur Institute by Albert Calmette and Camille Guérin and announced to the medical community in 1921. In the course of their earlier research they had noted that repeated sub-culturing of the TB bacteria reduced its virulence, so they purposefully set out to decrease virulence through sub-culturing to create a vaccine. From 1908 the bacteriologist and veterinarian worked on creating an attenuated, or weakened, strain of Mycobacterium bovis that, when injected into animals, would not cause tuberculosis. After almost fifteen years and 230 transplantations of the bacteria, Calmette and Guérin achieved their goal. By 1921 their tests indicated that they had succeeded in producing a non-virulent strain of the bacteria and human trials began in France, Germany and Canada.

In Montreal Drs. J. A. Baudoin and Petit conducted studies on the use of BCG in newborns beginning in 1925. In 1934 they found that the vaccine reduced the risk of mortality of at risk children by 4.5 times the unvaccinated group. Their findings showed BCG to be particularly effective for children under one year of age living in a tuberculous household. By 1941 they had vaccinated 44,734 infants, and found that mortality was reduced in 0-1 year olds by 66%. For youth aged 0-15 mortality was reduced by 61%. As a result, Quebec began a program to vaccinate newborns and in 1949 began school vaccination campaigns.

Tests on the effectiveness of BCG were also undertaken by Dr. R. G. Ferguson in Fort Qu'Appelle, Saskatchewan. Working with the Native population conducting tuberculin tests, Ferguson found high rates of TB in the Native community and a mortality rate that was ten times greater than the White community. In light of these observations, Ferguson sought permission to test BCG within the aboriginal population of Fort Qu'Appelle. He began administering the vaccine in 1933. By 1938 preliminary results showed that although the overall mortality rate between vaccinated and unvaccinated groups remained the same, the mortality rate of children in a tuberculous environment decreased by 75%.

Although there was initially mixed reaction to the BCG vaccine, by 1948 subsequent tests, such as those by Baudoin and Ferguson, were convincing the medical community of the benefits of the vaccine to certain communities.

As demonstrated by such medical researchers, the BCG vaccine is especially good at preventing TB infection in children, but has much more variable results (0-80% efficacy) at preventing pulmonary TB in adolescents and adults.

The BCG vaccine continues to be used around the world to prevent TB infection. It is given, for example, to all children under the age of three in South Africa. It is not given in areas of low TB incidence though, because the vaccine decreases the efficacy of tuberculin skin tests; it is uncommon among native-born Canadians and Americans.

- **New developments**

Although the BCG vaccine continues to be used around the world, its limitations in consistently preventing tuberculosis in adult populations have led many medical researchers to seek a more effective vaccine.

Aeras, a non-profit product development organization, is at the forefront of the development of a new vaccine. In collaboration with a number of scientific partners, Aeras is working toward the goal of eliminating TB by 2050 through the development of vaccines and biopharmaceuticals. It currently has six new vaccines in trial, including MVA85A, developed by Dr. Helen McShane at the University of Oxford, which is intended to boost immune system response, and Aeras-402/CrucellAd35, which is a replication-deficient adenovirus containing M. tuberculosis antigens and is hoped will boost T-cell responses. In partnership with Statens Serum Institute, in December 2011

TEACHER KEY

Aeras announced a trial for a vaccine (SSI / SP H4-IC31) designed to prevent people with latent TB infections from developing the active disease.