Operation Outbreak
Educational Overview

CDC Science Ambassador

Introduction

The Centers for Disease Control and Prevention (CDC) Science Ambassador Fellowship program is proud to present a supplemental series of educational activities for *The Junior Disease Detectives, Operation: Outbreak,* a graphic novel by CDC, the U.S. Department of Agriculture (USDA), and 4-H (the youth development organization affiliated with USDA and National Institute of Food and Agriculture). Activities were developed as a collaboration between CDC's Science Ambassador Fellowship program, CDC's Influenza Division, and science, technology, engineering, and mathematics (STEM) teachers from across the country who participated in the 2017 CDC Science Ambassador Fellowship.

Each activity features a different public health concept presented in the graphic novel. Teachers are provided with an introduction to the public health concept and with discussion questions to assess student learning. Step-by-step instructions guide teachers through a problem-based activity aligned with national standards. An answer key for each activity is provided.

Activities

1. The Outbreak Team
2. Eddie's Story
3. Hamlet's Story

Age or grade level

The activities are intended for middle and high school teachers to teach public health using the *The Junior Disease Detectives, Operation: Outbreak* graphic novel in the classroom.

Duration

45 minutes per activity

Learning objectives

Each supplemental activity focuses on 3–5 learning objectives targeting knowledge of public health concepts and at least one of the following five problem-based skills: collaborative performance, scientific design, identifying trends, decision-making, and implementing action plans.

At the end of the activities, students should be able to

- Identify steps in an influenza outbreak investigation.
- Identify roles and responsibilities of public health, animal health, environmental health, and other relevant professionals in an influenza outbreak investigation and the skills each needs to fulfill their roles.
- Describe why using a One Health approach connecting human, animal, and environmental health is best when investigating or preventing zoonotic diseases.
- Define terms like "case," "case definition," "index case," and "case classification."
- Describe how a case definition is used to help investigate an outbreak.
- Differentiate between a "suspected," "probable," and "confirmed" case.
- Explain how a case definition can change over the course of an outbreak.
- Define *zoonotic influenza virus*.
- Explain how some influenza viruses in animals have the potential to cause disease in humans, and how some influenza viruses in humans can cause infections in animals.
- Define *variant virus* and explain how it is a specific kind of zoonotic influenza virus in humans; also explain risk factors for variant virus infections in people.

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- Differentiate between direct and indirect transmission and explain the different modes of transmission through which influenza viruses can spread between hosts, such as humans and animals.
- Define *novel influenza virus* and explain how zoonotic and novel influenza A virus infections on rare occasions can cause pandemics among humans.
- Communicate influenza prevention recommendations to different audiences.

National standards

The activities have been aligned with CDC's Epidemiology and Public Health Science (EPHS) Core Competencies for High School Students[1] and Next Generation Science Standards* (NGSS)[2] Science & Engineering Practices and Crosscutting Concepts.

[1] Centers for Disease Control and Prevention (CDC). Science Ambassador Workshop—Epidemiology and Public Health Science: Core Competencies for high school students. Atlanta, GA: US Department of Health and Human Services, CDC; 2015.

[2] NGSS Lead States. Next Generation Science Standards: For States, By States (Appendix F–Science and Engineering Practices, Appendix G–Crosscutting Concepts). Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS. 2013. Available at: http://www.nextgenscience.org/get-to-know.

* Next Generation Science Standards is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards was involved in the production of, and does not endorse, this product.

Background information

This information provides a scientific overview of influenza viruses, transmission, and prevention.

Influenza, commonly known as "flu," is a contagious respiratory illness caused by influenza viruses. Influenza infection can cause mild to severe illness in people. There are four types of influenza viruses: A, B, C, and D. Human influenza A and B viruses cause annual seasonal epidemics in people in the United States, typically during the fall and winter. These yearly influenza epidemics are commonly known as the "flu season".

Influenza A viruses are divided into subtypes based on two proteins on the surface of the virus: hemagglutinin (HA) and neuraminidase (NA). Scientists are aware of the existence of 18 different hemagglutinin subtypes (abbreviated as H1 through H18) and 11 different neuraminidase subtypes (i.e., N1 through N11). The current subtypes of influenza A viruses that regularly cause illness in people are influenza A (H1N1) and influenza A (H3N2). Influenza B viruses are not divided into subtypes, but can be further classified into two lineages: B/Yamagata and B/Victoria. Influenza B viruses mainly infect humans, but in addition to humans, influenza A viruses also are found in many different animals. For example, influenza A viruses are found in birds, bats, pigs, whales, horses, seals, dogs, and cats. The influenza A viruses that circulate among animals are different from those among people.

An important property of all influenza viruses is that they are always changing. The most common way that influenza viruses change is through antigenic drift. Antigenic drift refers to small changes in the genes of influenza viruses that occur over time. The second way that influenza viruses can change is called antigenic shift. Antigenic shift is an abrupt, major change in influenza A viruses, resulting in a new influenza A virus subtype that infects people. Although all influenza viruses are constantly changing by antigenic drift, antigenic shift happens less frequently and only among influenza A viruses. When antigenic shift happens, it can rarely result in a flu pandemic, but certain conditions must first be met.

A flu pandemic is a global outbreak of disease caused by the emergence of a *novel* influenza A virus that has acquired the ability to spread efficiently and in a sustained manner among people. The term *novel* is used to describe an influenza A virus that enters a new species (animal or human) in whose population the virus does not normally circulate. Influenza A viruses that regularly spread among animals tend to be novel in humans, so people generally do not have preexisting immune protection against these viruses. Four flu pandemics have occurred in approximately the last 100 years: 1918, 1957, 1968, and 2009.

Certain specific influenza A viruses from animals can cause infections and outbreaks among people. The term *zoonotic disease* or *zoonoses* is used to describe infections that can spread between animals and people and cause disease. For example, occasional human infections and outbreaks associated with

influenza A viruses that circulate among birds or pigs have occurred in the past.

Most human infections with novel influenza A viruses have occurred after close contact with infected animals, which might not exhibit signs and symptoms of illness. Public health and animal health professionals closely monitor and investigate human infections caused by zoonotic diseases. In recent years, public health professionals have paid close attention to human infections and outbreaks with avian influenza (i.e., bird flu) viruses, such as avian influenza A (H5N1) and avian influenza A (H7N9), because these viruses have caused severe illness and death among infected people. Currently, these viruses do not have the ability to spread easily among people.

Influenza A viruses that circulate among pigs (i.e., swine) occasionally infect people, and when they do, this is considered a zoonotic infection in humans. When an influenza A virus that usually spreads in pigs infects a person, this is called a variant virus infection and is denoted by adding the letter *v* to the virus name. For example, influenza A(H3N2)v. Variant viruses are novel among people because they are different from the influenza A viruses that typically circulate among humans, therefore, most people do not have existing immune protection or antibodies that protect against them. Variant virus infections have occurred in different agricultural settings, but the largest outbreaks have been associated with attendance at agricultural fairs, where large numbers of pigs and people from different geographic areas come together.

The largest known outbreak of variant influenza occurred in 2012, when 309 influenza A(H3N2)v virus infections were reported in 12 states. Most of these infections occurred among people exposed to infected pigs at agricultural fairs. A few instances of limited human-to-human spread of variant viruses also were reported that year. These are infections that occur in a limited manner from one person to another (generally, a household contact) without spreading to additional people (i.e., inefficient spread).

Like seasonal influenza A virus infections, variant virus infections can result in mild human illness, but more severe illness and death also have been reported. A relatively small number of variant virus infections are reported each year in the United States. Because of the ever-changing nature of influenza, global surveillance of circulating influenza A viruses among both animals and people is conducted to not only monitor changes in seasonal influenza viruses, but also to detect the emergence of novel influenza A viruses that could trigger a pandemic. CDC and USDA take a One Health approach when investigating variant virus infections.

One Health recognizes that human health, animal health, and the environment are connected. A One Health approach requires human, animal, and environmental health professionals to work together at the local, state, federal, and global levels to improve the health of people, animals, and their shared environment.

One goal of experts investigating a variant virus outbreak is to ensure these viruses are not changing in ways that would allow them to spread more easily among people (person-to-person transmission) and cause a pandemic.

There are associations between zoonotic influenza viruses and pandemics. The past four influenza pandemic viruses had genes derived from influenza A viruses in birds or pigs. Pigs are often called a mixing vessel when it comes to influenza because in addition to influenza A viruses that usually circulate among pigs, they also can be infected with influenza A viruses that usually circulate among people and birds. Whereas pigs can occasionally transmit their viruses to people, people also can transmit human seasonal influenza viruses to pigs. Sometimes, pigs can be infected with multiple influenza A viruses from different species at the same time. When this happens, it is possible for the genes of these different viruses to mix and create a new influenza A virus. This process is called **reassortment** and is one way that antigenic shift can occur.

Reassortment is one important way that novel (i.e., new) influenza A viruses can enter the

human population from animals. In fact, health experts believe the 2009 H1N1 flu pandemic was caused by reassortment between influenza A viruses from North American pigs, Eurasian pigs (i.e., pigs from Europe and Asia), birds, and humans, making it a quadruple reassortant virus.

CDC, USDA, and our local and state public health, animal health, environmental health partners work collaboratively with each other and also with industry to minimize transmission of influenza A viruses between pigs and people at agricultural exhibitions and fairs.

We collectively recommend that people consider appropriate behaviors and actions to prevent the spread of influenza A viruses among pigs, and from pigs to people. Examples of prevention measures include checking animal health status upon arrival at an agricultural fair, shortening the time pigs are on the fairgrounds, contacting a veterinarian when pigs display signs of illness, isolating ill pigs, maintaining a veterinarian on call, providing handwashing stations, providing education on the importance of washing hands after being around animals, and prohibiting food and beverages in animal barns. Warnings that people at high risk for flu-associated complications (e.g., children younger than 5 years of age, people 65 years and older, pregnant women, and people with certain long-term health conditions, such as diabetes, asthma, or heart disease) should not enter pig barns should be posted. In addition, people who have symptoms of respiratory illness also should not enter the swine barn to prevent the spread of human flu viruses to pigs. See the resources section for a list of people at high risk for serious flu-associated complications.

Resources

These resources are provided as background and reference material.

CDC Resources

Key facts about influenza (flu) (https://www.cdc.gov/flu/keyfacts.htm)

Types of influenza viruses (https://www.cdc.gov/flu/about/viruses/types.htm)

How the flu virus can change: “drift” and “shift” (https://www.cdc.gov/flu/about/viruses/change.htm)

Transmission of influenza viruses from animals to people (https://www.cdc.gov/flu/about/viruses/transmission.htm)

CDC One Health website (https://www.cdc.gov/onehealth)

Images of influenza viruses (https://www.cdc.gov/flu/resource-center/freeresources/graphics/images.htm)

People at high risk for developing flu-related complications (https://www.cdc.gov/flu/about/disease/high_risk.htm)

Information on swine influenza/variant influenza virus (https://www.cdc.gov/flu/swineflu/index.htm)

Key facts about swine influenza (swine flu) in pigs (https://www.cdc.gov/flu/swineflu/keyfacts_pigs.htm)

Take action to prevent the spread of flu between pigs and people (https://www.cdc.gov/flu/swineflu/variant/preventspreadfactsheet.htm)

Reported infections with variant influenza viruses in the United States since 2005 (https://www.cdc.gov/flu/swineflu/variant-cases-us.htm)

Case count: detected U.S. human infections with H3N2v by state since August 2011 (https://www.cdc.gov/flu/swineflu/h3n2v-case-count.htm)

Pandemic influenza (https://www.cdc.gov/flu/pandemic-resources/index.htm)

Monitoring for influenza viruses (https://www.cdc.gov/flu/pandemic-resources/monitoring/index.html)

CDC Says “Take 3” Actions to Fight the Flu (https://www.cdc.gov/flu/protect/preventing.htm)

USDA-Recommended Resources

National Association of State Public Health Veterinarians: compendium of measures to prevent disease associated with animals in public settings, 2017 (http://nasphv.org/documentsCompendiumAnimals.html)

Influenza in swine (https://www.usda.gov/topics/animals/one-health/influenza-swine)

USDA One Health website (https://www.usda.gov/topics/animals/one-health)

USDA surveillance for influenza A virus in swine (https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/sa_animal_disease_information/sa_swine_health/ct_siv_surveillance/)

Zoonotic influenza and measures for prevention at fairs (http://nasphv.org/documentsCompendiaZoonoticInfluenza.html)

Information

Authors
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CDC’s Center for Surveillance, Epidemiology, and Laboratory Services
The following experts in education from the U.S. Centers for Disease Control and Prevention provided leadership, content development, and editing for these activities: Kelly Cordeira, MPH, Student Programs and Partnerships Lead, Division of Scientific Education and Professional Development, Center for Surveillance, Epidemiology, and Laboratory Services.

CDC Science Ambassador Fellows
The following STEM teachers who participated in the 2017 CDC Science Ambassador Fellowship within CDC’s Division of Scientific Education and Professional Development co-developed the educational activities in consultation with CDC experts: Richard Blauvelt, MPH, MAT (Harper Woods, Michigan); Tami Caraballo, MEd (Snohomish, Washington); Karen Krieger, MSSE (Phnom Penh, Cambodia); Sarah Sletten, PhD (Fargo, North Dakota); Tina Gibson, MS EdD, 2017 Peer Leader (Columbus, Mississippi); Clara Bennion, MSEd (Camdenton, Missouri); Pam Gilmore, MS (Muskego, Wisconsin); Larisa Masson (Portland, Oregon); Susannah Miller, MA (Indianapolis, Indiana); Valencia LaPrelle’ Williams, PhD, 2017 Peer Leader (Ontario, California).

CDC’s National Center for Immunization and Respiratory Diseases
The following experts from the U.S. Centers for Disease Control and Prevention provided consultation: Douglas Jordan, MA, Influenza Division, National Center for Immunization and Respiratory Diseases; Lt. Col. (R) Joe Gregg, Influenza Coordination Unit, National Center for Immunization and Respiratory Diseases; Alicia Budd, MPH, Influenza Division, National Center for Immunization and Respiratory Diseases; James Kile, DVM, MPH, Influenza Division, National Center for Immunization and Respiratory Diseases

CDC’s National Center for Emerging and Zoonotic Infectious Diseases
The following experts from the U.S. Centers for Disease Control and Prevention provided consultation: Michael Jhung, MD, MPH, Division of Foodborne, Waterborne, and Environmental Diseases, National Center for Emerging and Zoonotic Infectious Diseases

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