CDC Science Ambassador

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TEACHING TOMORROW'S DISEASE DETECTIVES

A CDC initiative to ignite student interest in public health as a STEM career choice

EDUCATIONAL OVERVIEW

OPERATION: OUTBREAK

INTRODUCTION

The Centers for Disease Control and Prevention's (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 Influenza Division, CDC's Science Ambassador Fellowship program, and 10 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 and teacher resources are provided for each activity.

ACTIVITIES

Activities will be released throughout the summer and fall of 2018.

1. The Operation 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 their classrooms. The age and grade level varies by activity.

DURATION

45 minutes per activity

LEARNING OBJECTIVES

Each supplemental activity focuses on 2–4 learning objectives targeting knowledge of public health concepts and 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

- Explain how some influenza (flu) viruses in animals have the potential to cause disease in humans, and how some influenza viruses in humans can cause animal flu infections; also, define *zoonotic influenza virus*.
- 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.
- Define *novel influenza virus* and explain how zoonotic and novel influenza A virus infections — on rare occasion — may cause pandemics among humans.
- Identify steps in an influenza outbreak investigation.
- Identify roles and responsibilities of public health and animal health professionals in an influenza outbreak investigation and the skills each needs to fulfill their roles.
- Describe why using a one health (i.e., a combined human and animal health) approach is best when investigating or preventing zoonotic diseases.
- 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 the flu, is a contagious respiratory illness caused by influenza viruses. It 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 seasonal epidemics of human disease almost every year in the United States, typically during October–May. 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, respectively). 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.

Influenza viruses 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 viruses 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 humans. When antigenic shift happens, a pandemic can occur. Although all influenza viruses are constantly changing by antigenic drift, antigenic shift happens only occasionally and only among influenza A viruses.

A flu pandemic is a global outbreak of disease that can occur when a novel (i.e., new among humans) influenza A virus emerges and gains the ability to spread efficiently and in a sustained manner among people. Four flu pandemics have occurred in the last 100 years: 1918, 1957, 1968, and 2009. 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 from animals tend to be novel in humans, so people generally do not have preexisting immune protection against these viruses.

In addition to people, influenza A viruses are found in many different animals, including birds, bats, pigs, whales, horses, seals, dogs and cats. The influenza A viruses that circulate among animals are different from those in people. 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 swine (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 in infected people. Currently, these viruses do not have the ability to spread easily among people.

Influenza A viruses that circulate among swine occasionally transmit to people, and when they do, this represents a zoonotic infection in

humans. When an influenza A virus from a pig 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 humans because they are different from the influenza A viruses that typically circulate among humans, and most people do not have existing immune protection or antibodies that protect against novel viruses. Variant virus infections can occur in different agricultural settings, but the largest outbreaks have been associated with 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 virus infections also were reported that year. These infections spread 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 often have resulted in mild human illness, but more severe illness and death have also been reported. Sporadic variant virus infections are reported each year in the United States. Because of the ever-changing nature of flu, 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. Public and animal health professionals investigate variant virus infections to ensure these viruses are not changing in ways that would allow them to spread more easily among people 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.

The same people that are at high risk of human flu-associated complications are at high risk for variant flu infections. 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 be discouraged from entering swine barns also can be posted. 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.h tm)

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

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

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

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)

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)

INFORMATION

Activities were developed as a collaboration between the CDC Science Ambassador Fellowship; ten Science, Technology, Engineering, and Mathematics (STEM) teachers from across the country who participated in the 2017 CDC Science Ambassador Fellowship; and CDC's Influenza Division.

CDC's Division of Scientific Education and Professional Development
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 Influenza Division
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