CDC Science Ambassador Workshop
2015 Lesson Plan

Seasonal Flu Costs How Much?!

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Contact Information

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Seasonal Flu Costs How Much?!

Summary

Seasonal influenza (flu) can be a serious disease that leads to hospitalization and occasionally death. Every flu season is different because the types and subtypes of influenza viruses can change each year. Although persons with underlying illness are more likely than others to have severe consequences of flu, even otherwise healthy persons can get sick and spread it to others. During 31 flu seasons (1976–2007) estimates of flu-associated annual deaths in the United States range from a low of approximately 3,000 to a high of approximately 49,000 persons dying from a condition associated with flu each year.

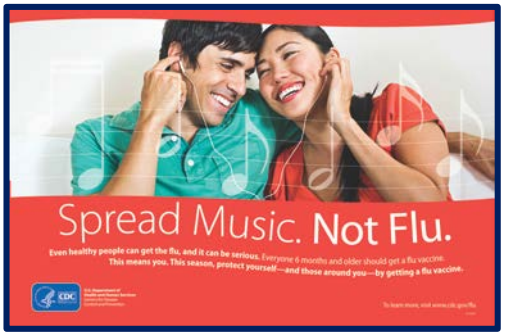

Figure 1: CDC's Spread Music. Not Flu. *poster promoting the 2015 flu vaccine to young adults.*

Everyone aged 6 months and older should get a seasonal flu vaccination every year. This recommendation has been in place since February 24, 2010, when CDC's Advisory Committee on Immunization Practices voted to expand protection against the flu to more persons in the United States. The traditional flu vaccine is trivalent, developed to protect against three different flu viruses (which vary from year to year). In addition, there are quadrivalent vaccines, developed to protect against four different flu viruses that change year-to-year. The majority of vaccines are made from inactivated influenza virus. In 2003, a live attenuated influenza vaccine in nasal spray form became available[1]. Attenuation takes an infectious agent and alters it so it is viable (or live), but harmless or less virulent.

This lesson examines the economic effects associated with seasonal flu and vaccination decisions. It is based on a study by the Centers for Disease Control and Prevention[2], published in the journal *Vaccine*[3], that estimated an average dollar figure for visits to doctor's offices and emergency departments (EDs) for treatment of children ill with flu, and examined the amount of time parents have to miss from work to care for children while they recover. The study examined the experience of 282 children under the age of 5 in 3 U.S. cities, and reported that parents had medical expenses ranging from approximately $300 to approximately $4,000, and missed 11–73 hours of work, depending on whether their child was able to recover at home or was hospitalized. Students will be presented with a scenario regarding vaccination. They will examine three vaccination decision options. For each, they will consider direct and indirect economic costs associated with influenza. They will perform mathematical calculations for each option to evaluate and determine the most cost-effective course of action.

The target grade level for this lesson is high school grades 9 or 10. Students need only basic prior knowledge of influenza and vaccines, although the teacher can choose to provide prior instruction about viruses and vaccinations.

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[1] CDC. Seasonal Flu. *CDC*. CDC. http://www.cdc.gov/flu/index.htm. Updated October 2, 2015. Accessed April 14, 2016.

[2] CDC. CDC Study Treating Children's Flu Illness Costly. *CDC*. CDC. http://www.cdc.gov/flu/spotlights/childrens-flu-costly.htm. Updated May 21, 2012. Accessed April 14, 2016.

[3] Ortega-Sanchez IR, Molinari NM, Fairbrother G, et al. Indirect, out-of-pocket and medical costs from influenza-related illness in young children. Vaccine. June 13, 2012;30(28):4175-4181. Online: http://www.sciencedirect.com/science/article/pii/S0264410X12005932.

Learning Outcomes

After completing this lesson, students should be able to

- Describe scientific, social, and economic considerations that affect the choice of intervention strategies;
- Mathematically analyze data to determine cost effectiveness of vaccination program options; and
- Construct an argument to make a decision about implementing a vaccination strategy by using evidence.

Duration

This lesson can be conducted as one 90-minute lesson or divided into two 45-minute lessons.

Procedures

Day 1: Calculating the cost of influenza (45 minutes)

Preparation

Before Day 1,

- Print copies of Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A), one copy per student. Each part will be handed out separately.
- Review Worksheet 1B: Seasonal Flu Costs How Much?! Guide (Appendix 1B).
- Review cdc.gov/flu/ about the flu for the first part of day one.
- Review the other online resources used in Worksheet 1A, including, the CDC study, Treating Children's Flu Illness Costly (http://www.cdc.gov/flu/spotlights/childrens-flu-costly.htm) and the journal article titled "Indirect, out-of-pocket and medical costs from influenza-related illness in young children" (Ortega-Sanchez RI, Molinari NA, Fairbrother G, et al. Vaccine. 2012 Jun 13;30(28):4175–81.)

Materials

- Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A)
  Description: Students explore the costs of receiving an influenza diagnosis. Students analyze the direct medical costs of getting sick as well as indirect costs (e.g., parent time-cost and student time-cost). Students will also review the costs associated with a vaccination program. Then, students consider the trade-offs of having a vaccination program by using two vaccination options.
- Worksheet 1B: Seasonal Flu Costs How Much?! Guide (Appendix 1B)
  Description: The guide provides answers and additional information that will help guide students through this exercise.
- Calculator
  Description: Students will perform basic mathematical calculations.

Online Resources

- CDC Influenza
  URL: http://www.cdc.gov/flu/
  Description: This website provides background information regarding seasonal flu. Use this website to help answer any questions or to review any misconceptions about the flu.
- CDC Study: Treating Children's Flu Illness Costly
  URL: http://www.cdc.gov/flu/spotlights/childrens-flu-costly.htm.
  Description: CDC provides a summary of the journal article published in the journal *Vaccine* titled "Indirect, out-of-pocket and medical costs from influenza-related illness in young children."
- Journal article titled "Indirect, out-of-pocket and medical costs from influenza-related illness in young children."
  URL: http://www.sciencedirect.com/science/article/pii/S0264410X12005932.
  Description: This journal database provides a free, downloadable copy of the journal article above. The study objective was to determine indirect, out-of-pocket, and direct medical costs of laboratory-confirmed medically attended influenza among young children.

Activity

1. Ask students what they know about seasonal flu. Write student responses on the board under the headings as follows: Virus, Transmission, Symptoms, Prevention, Vaccination, and Patterns. Review any concepts that students are unclear on. Use http://cdc.gov/flu to answer any questions or review any misconceptions.
2. Hand out Part 1 of Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A). Instruct a volunteer to read the first two paragraphs. Reiterate that students will be exploring the question, How much does it cost you and your family if you get the flu? Split students into group of no more than 4 students per group. Tell students to answer Question 1 with their group and to be prepared to share their answers with the class.
3. Regroup to a larger class discussion when students have completed Part 1. Ask for a student volunteer from each group to suggest what types of costs they came up with. Write the costs on the board in three categories: Medical Costs, Indirect Costs, and Out-of-pocket Costs.
4. Hand out Part 2 of Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A). Instruct a volunteer to read the paragraph. As a class, ask students to consider what they come up with and what studies have been used to estimate costs. Ask students what other factors they might consider when estimating costs. Use this as an opportunity to suggest that severity might influence influenza costs directly.
6. Hand out Part 3 of Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A) as student groups complete Question 3. Explain to each group that they are to complete Part 3 as a group and to be prepared to share their answers.
7. Draw Table 2 on the board. With approximately 10 minutes remaining, ask for a student volunteer from each group to fill in two items with the respective values that their group came up with. After all groups have contributed, regroup for a larger class discussion. Discuss the costs that students described. Ask students to agree on each cost and to add any other costs that did not make it on the board. As a class, calculate the total cost (i.e., medical facility costs, parent time-cost, out-of-pocket expenses, and student expenses) of having the flu, from hospitalizations, emergency department visits, and outpatient (office) visits. Have students discuss which scenario they think is most common. Present the information provided for Question 4.

Day 2: Tailoring a vaccination program at school, 45 minutes

Preparation

Before Day 2,

- Review CDC Influenza Prevention for the first part of Day 2.
- Review CDC Flu Vaccine Effectiveness and the two *Morbidity Mortality Weekly Report* (*MMWR*) articles concerning the 2013–14 flu season.
- Review Parts 4-5 of Worksheet 1A: Seasonal Flu Costs How Much?! Guide (Appendix 1A).

Materials

- Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A)
  Description: Students explore the costs of getting influenza. Students analyze the direct medical costs of getting sick as well as indirect costs (e.g., parent time-cost and student time-cost). Students will also review the costs associated with a vaccination program. Then, students consider the trade-offs of having a vaccination program using two vaccination options.
- Worksheet 1B: Seasonal Flu Costs How Much?! Guide (Appendix 1B)
  Description: The guide provides answers and additional information that will help guide students through this exercise.
- Calculator
  Description: Students will perform basic mathematical calculations.

Online Resources

- CDC Influenza Prevention
  URL: http://www.cdc.gov/flu/protect/preventing.htm.
  Description: This website provides background information for seasonal flu prevention. Use this website to help answer any questions or to review any misconceptions about the flu prevention.
- CDC Flu Vaccine Effectiveness
  URL: http://www.cdc.gov/flu/professionals/vaccination/effectivenessqa.htm.
  Description: This resource provides information on the effectiveness of the flu vaccine. Reviewing this information in advance might be helpful.
- CDC. Interim estimates of 2013–14 seasonal influenza vaccine effectiveness — United States
  URL: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6430a3.htm.
  Description: The resource provides information on the 2013–14 seasonal flu. Part 4 refers to this study. Reviewing this information in advance might be helpful.
- CDC. Update: Influenza activity — United States, September 29, 2013–February 8, 2014.
  URL: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6307a3.htm.
  Description: The resource provides information on the 2013–14 seasonal flu. Part 4 refers to this study. Reviewing this information in advance might be helpful.

Activity

1. Review Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A), Parts 1–3 from Day 1.
2. Ask students how the flu can be prevented. On the board, write down their suggestions. Have students rank the ideas from most effective to least effective.
3. Hand out Part 4 of Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A). Suggest to students that you will focus on flu vaccination to prevent the flu. Explain that prevention effectiveness is a way to measure how well a flu vaccination program works to make decisions about the future of the program. Ask for volunteers to read the paragraphs. Ask Question 7 out loud and answer the question as a class.
4. Hand out Part 5 of Worksheet 1A: Seasonal Flu Costs How Much?! (Appendix 1A). Direct students to answer Question 8 on their own. Ask a few volunteers to read their answers out loud. Write a basic definition on the board for students to refer to. For example, “efficacy = controlled situation, ideal” and “effectiveness = real-world”.
4. Ask Question 9 aloud. Have students turn to a neighbor to discuss. After a few minutes, ask for student volunteers to answer the question. Take this opportunity to review bias. See the guide for more information on bias.
5. Rearrange student into their groups from Day 1. Instruct students to compete Part 5. Walk around to make sure student are staying on track. The formulas for the calculations for Table 3 are provided in the guide. When all groups have completed their calculations, show students the answers to Table 3 on the board.
6. Regroup for a class discussion with approximately 5–10 minutes remaining. Pose Questions 14–16 to the class. Ask for volunteers to share their responses.
7. For homework, assign students to write a 1–2 page proposal for a vaccination program at your school. Students should present the information from the cost analysis to present the “best” option. Both direct and indirect costs should be considered. This product can be used as a summative assessment.

Conclusions

Through this lesson, students will use a systematic, public health approach to learn about influenza and prevention effectiveness, also called public health economics. By using data and scientific estimates of the direct and indirect cost of the flu, students refine mathematical skills and apply them to a real-world scenario. Analyzing scientific evidence through the eyes of students provides them with the insight as to how social and economic factors can often substantially influence decision making and oftentimes outweigh scientific evidence. Developing a tailored vaccination program for their school helps students think strategically about how to construct a winning argument.

Assessment

- Assessment 1: Homework for Worksheet 1: Seasonal Flu Costs How Much?! (Appendix 1A)
  Learning Outcomes Assessed
  - Describe scientific, social, and economic considerations that impact the choice of intervention strategies.
  - Mathematical analyze data to determine the cost effectiveness of vaccination program options.
  - Construct an argument using evidence to make a decision about implementing a vaccination strategy.

  Description: This individual summative assessment provides students with an opportunity to write a 1–2 page proposal for a vaccination program at their school. Students should present the information from the cost analysis to present the "best" option. Both direct and indirect costs should be considered.

Educational Standards

In this lesson, the following CDC Epidemiology and Public Health Science (EPHS) Core Competencies for High School Students[1], Next Generation Science Standards* (NGSS) Science & Engineering Practices[2], and NGSS Cross-cutting Concepts[3] are addressed:

HS-EPHS 4-1: Describe a model illustrating how scientific, social, economic, environmental, cultural, and political systems influence intervention performance patterns.

NGSS Key Science & Engineering Practice[2]
Developing and Using Models Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
NGSS Key Crosscutting Concept[3]
Patterns Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.

HS-EPHS 4-2: Use a targeted health promotion and communication approach (taking into consideration scientific knowledge, the organization of systems and their performance patterns, prioritized criteria, and trade-off considerations) to design intervention strategies.

NGSS Key Science & Engineering Practice[2]
Constructing Explanations and Designing Solutions Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations
NGSS Key Crosscutting Concept[3]
Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function.

HS-EPHS 4-3: Evaluate competing health-related intervention strategies using a systematic assessment to improve effectiveness.

NGSS Key Science & Engineering Practice[2]
Engaging in Argument from Evidence Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, ethical considerations)
NGSS Key Crosscutting Concept[3]
Patterns Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments

*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.

[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). Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS. 2013. Available at: http://www.nextgenscience.org/sites/ngss/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf.

[3] NGSS Lead States. Next Generation Science Standards: For States, By States (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/sites/ngss/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf.

Appendices: Supplementary Documents

Worksheet 1A

Seasonal Flu Costs How Much?!
Part 1

Name: _____ Date: _____

Directions: Read the information below about the flu and answer the questions when prompted.

Part 1
Seasonal influenza is estimated to result in approximately 200,000 hospitalizations and 31 million outpatient visits annually in the United States. Direct medical costs of influenza illness among U.S. children have been estimated to be >$1.2 billion per year.

In Parts 1 and 2 of this activity, you will explore the question: How much does it cost you and your family if you get the flu? This might sound like a strange question. It is not like when you buy an item at the store and know exactly how much you paid for it. When the flu virus infects your body and you get sick, it is harder to calculate a cost that does not already have a specific dollar value on it.

Question 1: What costs can you come up with that can be associated with getting sick with the flu?

Seasonal Flu Costs How Much?!
Part 2

Name: _____ Date: _____

CDC studies have estimated the cost of the influenza by using multiple methods. Researchers have looked at medical costs, which can include the costs of diagnostic testing, medications, room fees and supplies, and physician services. More recently, researchers have also considered influenza-related indirect costs (e.g., time lost from work to care for children and take them to medical visits, time spent in hospitals for parents of hospitalized children) and out-of-pocket expenses (e.g., copayments, over-the-counter medication, and travel costs).

Question 2: How does your list in Question 1 compare with the items listed above? What other factors might you consider when estimating these costs?

Let us pretend that you have flu-like symptoms. The flu virus can cause mild to severe illness and often comes on suddenly. Symptoms include fever or feeling feverish, chills, cough, sore throat, runny or stuffy nose, muscle or body aches, headaches, fatigue, and sometimes vomiting or diarrhea. The majority of persons with the flu have mild illness. The majority of persons who get influenza will recover in a few days to <2 weeks, but certain persons will have severe symptoms (e.g., difficulty breathing or shortness of breath, pain or pressure in the chest or abdomen, sudden dizziness, confusion, and severe or persistent vomiting); flu-like symptoms that improve, but then return with fever and worse cough or develop complications (e.g., pneumonia) as a result of the flu, and certain symptoms can be life-threatening and result in death. Antiviral medications can decrease symptom severity and shorten the duration of the flu, and those who take them usually do not need further medical care. However, if symptoms are moderate or severe, or if you are at high risk for flu complications, you might need professional medical care.

Question 3: What action would you take if your symptoms are mild? Moderate? Severe? If you indicate that medical care is necessary, consider what kind of medical care you would need.

Seasonal Flu Costs How Much?!
Part 3

Name: _____ Date: _____

Directions: Read the information below about the flu and answer the questions when prompted.

Consider how much it might cost to have the flu depending on what type of medical care is sought out by you and your parents and needed. Table 1 presents information on estimated costs associated with influenza to parents of the patient (aged <18 years) with medical insurance. Costs are identified as medical facility cost, parent time-cost (the value of time lost from work), and out-of-pocket expenses.

Table 1: Economic costs of influenza per family of sick student

Item	Inpatient Hospitalization ($)	Emergency Department Visit ($)	Outpatient Doctor's Visit ($)
Medical Facility Costs			
Room and supplies	2,186	370	0
Physician fees	899	262	N/A
Parent time-cost (work)			
Value of time for physician visits	164 (8 hours)	146 (7 hours)	131 (7 hours)
Value of time for hospital or emergency room	1,201 (60 hours)	127 (6 hours)	N/A
Out-of-pocket Expenses			
Medical payments	78	11	10
Nonmedical payments	18	4	4
Over-the-counter drugs	9	11	10
Telephone costs	29	33	17
Travel	44	67	11

Source: Ortega-Sanchez IR, Molinari NM, Fairbrother G, et al. Indirect, out-of-pocket and medical costs from influenza-related illness in young children. Vaccine. June 13, 2012;30(28):4175-4181. Online: http://www.sciencedirect.com/science/article/pii/S0264410X12005932.

Question 4: What is the total estimated cost of the flu if you seek medical care through a doctor's visit? Emergency department? Or if you have a complication that requires hospitalization?

Question 5: Explain which situation you think is more common: Being hospitalized for influenza, visiting the doctor for influenza, or visiting the emergency room.

Question 6: The CDC study did not consider student time value, because it is difficult to quantify. With your group come up with at least five indirect costs to the student (e.g., classes missed). Then, place a dollar value on the indirect costs. Assume that hospitalization because of the flu would result in missing 9.1 days of school, flu with an emergency department visit would result in missing 2.5 days of school, and flu with a doctor's visit would result in missing 1 day of school. Pretend school is your job and use minimum wage as a starting point in assigning values. The federal minimum wage is $7.25 per hour. Fill in the table and use the space below to discuss how you determined dollar amounts in the space below.

Table 2: Economic Costs of Influenza to the Student

Item	Inpatient — hospitalization ($)	Emergency department visit ($)	Outpatient — doctor visit ($)
Student time cost			

Seasonal Flu Costs How Much?!
Part 4

Name: _____ Date: _____

Directions: Read the information below about the flu and answer the questions when prompted.

CDC recommends that everyone take time to get the flu vaccine, take everyday preventive actions to stop the spread of germs, and take antiviral flu drugs, if the doctor prescribes them. CDC also recommends that patients suspected of having influenza who are at high risk of flu complications or who are very sick with flu-like illness should receive prompt treatment with influenza antiviral drugs without waiting for confirmatory testing. (http://www.cdc.gov/flu/). Let's focus on the prevention effectiveness of the flu vaccine.

What is prevention effectiveness?
Prevention effectiveness, or public health economics, is based on the science of decision making.

Researchers can assess the influence of public health interventions (e.g., flu vaccine programs) on health outcomes (e.g., seasonal flu). Modeling can be used to look at the influence in terms of efficacy (i.e., the ability to produce a desired result in an ideal setting), effectiveness (i.e., the ability to produce a desired result in a real-world setting), and cost (e.g., direct and indirect). It can also account for scientific, economic, environmental, cultural, and political factors that influence the intervention.

By weighing these findings and considering trade-offs, informed decisions about the intervention can be made.

First, let's scale it down to your school. Your school, of 350 students, is considering a school-wide flu prevention program. The options being considered are presented in Table 3.

Table 3: Vaccination Options and Out-of-Pocket Costs

Option	Details	Cost per student
A	FluMist Quadrivalent (Live-attenuated influenza vaccine, quadrivalent) optional to all students during gym class, promotion of everyday prevention actions to stop the spread of germs (e.g., flyers and reminders)	$23.70
B	Injection vaccine (Inactivated influenza vaccine, quadrivalent) optional to all students during gym class, promotion of everyday prevention actions to stop the spread of germs (e.g., flyers and reminders).	$15.05
C	No vaccination offered, promotion of everyday prevention actions to stop the spread of germs (e.g., flyers and reminders)	$0

Question 7. What other factors might you consider before you start your calculations?

Seasonal Flu Costs How Much?!
Part 5

Name: _____ Date: _____

Directions: Read the information below about the flu and answer the questions when prompted.

How well the flu vaccine works (or its ability to prevent flu illness) varies substantially from season to season. The vaccine's effectiveness also can be different depending on who is being vaccinated. At least two factors play an important role in determining the likelihood that flu vaccine will protect a person from flu illness, including (1) characteristics of the person being vaccinated (e.g., age and health), and (2) the similarity or match between the predetermined flu viruses the flu vaccine is designed to protect against and the actual flu viruses spreading in the community during a given flu season. Each year, because of the lead time required to produce the vaccines, influenza experts have to *anticipate* which flu strains are likely to predominate during the coming flu season. Although they have substantial data and experience in making this prediction, another flu strain not included in the vaccine can infect the population that year. (http://www.cdc.gov/flu/about/qa/vaccineeffect.htm)

Two general types of studies are used to determine how well influenza vaccines work: randomized controlled trials and observational studies. The first type of study is called a randomized control trial (RCT). In an RCT, volunteers are assigned randomly to either a group that receives the vaccine or a group that receives a placebo (e.g., a shot of saline), and **vaccine efficacy** is measured by comparing the frequency of influenza illness between the vaccinated and the unvaccinated groups. The second type of study is called an observational study. In observational studies the study participants make their own decisions about whether or not to be vaccinated. In this type of study, **vaccine effectiveness** is measured by comparing the frequency of influenza illness between the vaccinated and unvaccinated groups. Researchers usually perform mathematical calculations to adjust for factors to make sure the groups with and without the vaccine are as similar as possible with regards to other things that might affect if they have flu or its severity. (http://www.cdc.gov/flu/professionals/vaccination/effectivenessqa.htm)

Question 8. In your own words, explain the difference between vaccine efficacy and vaccine effectiveness.

Question 9. Why might vaccine efficacy and vaccine effectiveness vary considerably?

Both FluMist Quadrivalent (live-attenuated influenza vaccine, quadrivalent) and an injection vaccine (inactivated influenza vaccine, quadrivalent) have generally been found to be around 50%–60% effective, on average.

Question 10. If RTCs of FluMist performed in the past had a vaccine efficacy of 62%, and observational studies done in a particular year showed an effectiveness of 59%, what could you say about the similarity or match between the flu viruses and the flu vaccine in this particular year?

During the 2013–14 flu season, vaccine effectiveness was estimated at 51% for all ages[4] and 56% for children aged 5–19 years[5]. Thus, influenza vaccine reduced the risk for having to go to the doctor for confirmed influenza by 51% across all ages and by 56% for those in your age group. Of those aged 5–19 years, 51% were vaccinated. During 2013–2014, it was estimated that 6.6% of all students aged 5–19 years old had the flu, with approximately 0.27% of patients being hospitalized for the flu and 50% of patients being attended by a doctor.[6]

Question 11: On the basis of the 2013–14 flu season, in your school of 350 students, how many students will get vaccinated? How accurate do you think this calculation is?

Question 12: List reasons why a student (aged <18 years) might not get the flu vaccination.

[4] CDC. Seasonal Influenza Vaccine Effectiveness, 2005-2016. Available at: http://www.cdc.gov/flu/professionals/vaccination/effectiveness-studies.htm

[5] CDC. Interim estimates of 2013-14 seasonal influenza vaccine effectiveness—United States, February 2014. MMWR, 2014 Feb 21;63(7):137-42.

[6] CDC. Estimated influenza illness and hospitalizations averted by vaccination—United States 2013-14 Influenza Season. MMWR, 2014 Dec 12;63(49): 1151-1154. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6349a2.htm

Question 13. Complete Table 4 for all options.

Table 4. Vaccination program costs.

	Option A	Option B	No program
Percentage of students expected to be vaccinated	**67%**	**49%**	**21%**
Vaccine Effectiveness	**53%**	**49%**	**N/A**
Students expected to be vaccinated			
Students expected to be vaccinated, but still at risk			
Students expected to be unvaccinated			
Cases of flu expected (Assume 6.6% of those aged 5–19 years get the flu)			
Cases of flu averted by vaccination program			
Cost to school from supplying vaccine			
Cost saved per case of flu averted.			

The calculation used for cases of flu expected and averted is basic. To account for more complex factors, CDC researchers use modeling to predict how influenza will spread on the basis of vaccination rates and vaccine effectiveness each year. Two of the main considerations in modeling are seasonal virus transmission if no one was vaccinated versus transmission if a percentage of persons were vaccinated. This helps CDC researchers identify more closely what an outbreak on a small or large scale would look like.

Influenza viruses are spread from person to person primarily through large-particle respiratory droplets (i.e., when an infected person coughs or sneezes near a susceptible person). The typical incubation period (i.e., time from when a person contacts the virus until he or she shows symptoms) for influenza is 1–4 days (average: 2 days). The majority of healthy persons might be able to infect others beginning one day before symptoms develop and up to 5–7 days after becoming sick. Assume that a person with influenza contacts 10 persons per day and that the influenza virus is transmitted among one of every 50 contacts. This would indicate that every infected person will likely infect 1.4 other persons. (http://www.cdc.gov/flu/about/disease/spread.htm.)

Question 14. If a student has the flu, what is the likelihood that more than the expected number will become sick? In other words, is the assumption of 1.4 new cases per person on the basis of 10 contacts per day reasonable? Explain how this will affect your calculations in Question 11. (Hint: How many contacts does a student at your school typically have per day, compared with the estimated number?)

Question 15. Consider the scenario. If the vaccine were offered in school, 49% of students would get the vaccine if it were the injection and 67% would get the vaccine if it were the nasal spray. If the vaccine were not offered in school, only 21% would get the vaccine. How does this influence your choice of options? What type of cost would you consider this to be?

Question 16. In the first parts of this exercise, you calculated certain direct and indirect costs to you and your family. On the basis of your findings, what option would you choose and why?

Homework: Develop a 1–2 page proposal for your school to start a vaccination program. Present the information from your cost analysis to advocate for the best option. Be sure to consider both direct and indirect costs. Explain that students will be asked to present their statements to the class during the following class period.

Worksheet 1B

Seasonal Flu Costs How Much?!
Part 1 (Answer Guide)

Name: _____ Date: _____

Note: Ask for a volunteer to read the first two paragraphs. Reiterate that students will be exploring the question: How much does it cost you and your family if you get the flu?

Directions: Read the information below about the flu and answer the questions when prompted.

Part 1
Seasonal influenza is estimated to result in approximately 200,000 hospitalizations and 31 million outpatient visits annually in the United States. Direct medical costs of influenza illness among U.S. children have been estimated to be >$1.2 billion per year.

In Parts 1 and 2 of this activity, you will explore the question: How much does it cost you and your family if you get the flu? This might sound like a strange question. It is not like when you buy an item at the store and know exactly how much you paid for it. When the flu virus infects your body and you get sick, it is harder to calculate a cost that does not already have a specific dollar value on it.

Question 1: What costs can you come up with that can be associated with getting sick with the flu?

Note: Split students into groups of no more than 4 students per group. Tell students to answer Question 1 with their group and to be prepared to share their answers with the class. Regroup to a larger class discussion when students have completed Part 1. Ask for a student volunteer from each group to indicate what types of costs they came up with. Write the costs on the board in three categories: Medical Costs, Indirect Costs, and Out-of-Pocket Costs.

Answer: Answers will vary, but should include things like doctor visits, over-the-counter medications, prescription medications, transportation costs (e.g., physician office, pharmacy, and ED), time off work, time out of school, hospitalization, child care costs of other children, and funeral expenses and lost income for those who die.

Seasonal Flu Costs How Much?!
Part 2 (Answer Guide)

Name: _____ Date: _____

CDC studies have estimated the cost of the influenza by using multiple methods. Researchers have looked at medical costs, which can include the costs of diagnostic testing, medications, room fees and supplies, and physician services. More recently, researchers have also considered influenza-related indirect costs (e.g., time lost from work to care for children and take them to medical visits, time spent in hospitals for parents of hospitalized children) and out-of-pocket expenses (e.g., copayments, over-the-counter medication, and travel costs).

Question 2: How does your list in Question 1 compare with the items listed above? What other factors might you consider when estimating these costs?

Note: As a class, ask students to consider what they came up with, compared with what studies have used to estimate costs. Ask student volunteers what other factors they might consider when estimating costs. Use this as an opportunity to indicate that the symptoms' severity might influence cost indirectly.

Answer: Answers will vary. Students will want to consider symptoms' severity.

Let us pretend that you have flu-like symptoms. The flu virus can cause mild to severe illness and often comes on suddenly. Symptoms include fever or feeling feverish, chills, cough, sore throat, runny or stuffy nose, muscle or body aches, headaches, fatigue, and sometimes vomiting or diarrhea. The majority of persons with the flu have mild illness. The majority of persons who get influenza will recover in a few days to <2 weeks, but certain persons will have severe symptoms (e.g., difficulty breathing or shortness of breath, pain or pressure in the chest or abdomen, sudden dizziness, confusion, and severe or persistent vomiting); flu-like symptoms that improve, but then return with fever and worse cough or develop complications (e.g., pneumonia) as a result of the flu, and certain symptoms can be life-threatening and result in death. Antiviral medications can decrease symptom severity and shorten the duration of the flu, and those who take them usually do not need further medical care. However, if symptoms are moderate or severe, or if you are at high risk for flu complications, you might need professional medical care.

Question 3: What action would you take if your symptoms are mild? Moderate? Severe? If you indicate that medical care is necessary, consider what kind of medical care you would need.

Answer: Answers will vary. If the symptoms are mild (e.g., fever, cough, sore throat, runny or stuffy nose, body aches, headache, chills, fatigue, and occasionally vomiting or diarrhea), CDC recommends staying home and avoiding contact with other persons. For moderate symptoms (i.e. symptoms are making you very sick or worried about your illness), a doctor's visit might be needed. If the symptoms are severe (e.g., difficulty breathing or shortness of breath, pain or pressure in the chest or abdomen, sudden dizziness, confusion, severe or persistent vomiting, or flu-like symptoms that improve but then return with fever and worse cough) or if you are in a high-risk group, CDC recommends getting medical care. For severe symptoms, ED might be necessary, and, hospitalization needed. (See http://www.cdc.gov/flu/takingcare.htm for more information.)

Seasonal Flu Costs How Much?!
Part 3 (Answer Guide)

Name: _____ Date: _____

Note: Explain to each group that they are to complete Part 3 and be prepared to share their answers.

Directions: Read the information below about the flu and answer the questions when prompted.

Consider how much it might cost to have the flu depending on what type of medical care is sought out by you and your parents and needed. Table 1 presents information on estimated costs associated with influenza to parents of the patient (aged <18 years) with medical insurance. Costs are identified as medical facility cost, parent time-cost (the value of time lost from work), and out-of-pocket expenses.

Table 1: Economic costs of influenza per family of sick student

Item	Inpatient Hospitalization ($)	Emergency Department Visit ($)	Outpatient Doctor's Visit ($)
Medical Facility Costs			
Room and supplies	2,186	370	0
Physician fees	899	262	N/A
Parent time-cost (work)			
Value of time for physician visits	164 (8 hours)	146 (7 hours)	131 (7 hours)
Value of time for hospital or emergency room	1,201 (60 hours)	127 (6 hours)	N/A
Out-of-pocket Expenses			
Medical payments	78	11	10
Nonmedical payments	18	4	4
Over-the-counter drugs	9	11	10
Telephone costs	29	33	17
Travel	44	67	11

Source: Ortega-Sanchez IR, Molinari NM, Fairbrother G, et al. Indirect, out-of-pocket and medical costs from influenza-related illness in young children. Vaccine. June 13, 2012;30(28):4175-4181. Online: http://www.sciencedirect.com/science/article/pii/S0264410X12005932.

Question 4: What is the total estimated cost of the flu if you seek medical care through a doctor's visit? Emergency department? Or if you have a complication that requires hospitalization?

Answer: Inpatient hospitalization for the flu is estimated to cost approximately $4,628. A patient who visits the emergency department has an estimated cost of approximately $1,031. A patient who visits the doctor has an estimated cost of $183.

Source: Ortega-Sanchez IR, Molinari NM, Fairbrother G, et al. Indirect, out-of-pocket and medical costs from influenza-related illness in young children. Vaccine. June 13, 2012;30(28):4175-4181. Online: http://www.sciencedirect.com/science/article/pii/S0264410X12005932.

Question 5: Explain which situation you think is more common: Being hospitalized for influenza, visiting the doctor for influenza, or visiting the emergency room.

Answer: Answers will vary. Note that students will not have specific numbers, but will likely conclude that persons most commonly visit their doctor. CDC estimates that approximately 200,000 persons are hospitalized each year with influenza and 31 million persons visit their doctor[1]. The average annual rate of ED visits for seasonal influenza has been estimated at approximately 500 per 100,000 persons[2,3]. If you use the 2016 U.S. population of approximately 320 million persons, you can estimate that there are approximately 160,000 ED visits per year (320,000,000 ÷ 100,000 × 500 ED visits).

Note: Explain to students that although ED visits cost less than hospitalization, so many persons use an ED to receive treatment for the flu that ED visits are a greater burden on the medical system and society (from an economic standpoint).

Sources

[1] Ortega-Sanchez IR, Molinari NM, Fairbrother G, et al. Indirect, out-of-pocket and medical costs from influenza-related illness in young children. Vaccine. June 13, 2012;30(28):4175-4181. Online: http://www.sciencedirect.com/science/article/pii/S0264410X12005932.

[2] Schanzer DL, Schwartz B. Impact of seasonal and pandemic influenza on emergency department visits, 2003-2010, Ontario, Canada. Acad Emerg Med., 2013;20(4): 388-97. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23701347.

[3]Uscher-Pines L., Elixhauser A. Emergency Department Visits and Hospital Inpatient Stays for Seasonal and 2009 H1N1 Influenza, 2008-2009. HCUP, 2013. Available at: http://www.hcup-us.ahrq.gov/reports/statbriefs/sb147.pdf

Question 6: The CDC study did not consider student time value, because it is difficult to quantify. With your group come up with at least five indirect costs to the student (e.g., classes missed). Then, place a dollar value on the indirect costs. Assume that hospitalization because of the flu would result in missing 9.1 days of school, flu with an emergency department visit would result in missing 2.5 days of school, and flu with a doctor's visit would result in missing 1 day of school. Pretend school is your job and use minimum wage as a starting point in assigning values. The federal minimum wage is $7.25 per hour. Fill in the table and use the space below to discuss how you determined dollar amounts in the space below.

Note: While students are working, draw Table 2 on the board. With approximately 10 minutes remaining, ask for a student volunteer from each group to fill in two items with the respective values that their group came up with. After all groups have contributed, regroup to a larger class discussion. Discuss the student costs that students came up with. Ask students to agree on each cost and to add any other costs that did not make it on the board. As a class, calculate the total cost (i.e., medical facility costs, parent time-cost, out-of-pocket expenses, and student expenses) of flu disease for hospitalization, emergency room visit, and outpatient visit (i.e., physician visit). Have students discuss which scenario they think is most common from Question 5. Present the information provided for Question 5.

Answer: Answers will vary. Some indirect costs include the cost of missing classes, quizzes or exams, important assemblies or general gatherings, sports practice, sports games, club meetings, and afterschool activities. Students should come up with reasons for each indirect cost. Students should pretend that school is their job and use minimum wage as an hourly rate for missing class (e.g., for hospitalization, time value would be $7.25 × 5.5 hours of instruction/day × 9.1 days = $362.86), with variations for important exams, sports games, and club activities.

Table 2: Economic Costs of Influenza to the Student

Item	Inpatient — hospitalization ($)	Emergency department visit ($)	Outpatient — doctor visit ($)
Student time cost			

Seasonal Flu Costs How Much?!
Part 4 (Answer Guide)

Name: _____ Date: _____

Note: Indicate to students that you will focus on flu vaccination to prevent the flu. Explain that prevention effectiveness is a way to measure how well a flu vaccination program works and to make evidence-based decisions.

Directions: Read the information below about the flu and answer the questions when prompted.

CDC recommends that everyone take time to get the flu vaccine, take everyday preventive actions to stop the spread of germs, and take antiviral flu drugs, if the doctor prescribes them. CDC also recommends that patients suspected of having influenza who are at high risk of flu complications or who are very sick with flu-like illness should receive prompt treatment with influenza antiviral drugs without waiting for confirmatory testing. (http://www.cdc.gov/flu/). Let's focus on the prevention effectiveness of the flu vaccine.

What is prevention effectiveness?
Prevention effectiveness, or public health economics, is based on the science of decision making.

Researchers can assess the influence of public health interventions (e.g., flu vaccine programs) on health outcomes (e.g., seasonal flu). Modeling can be used to look at the influence in terms of efficacy (i.e., the ability to produce a desired result in an ideal setting), effectiveness (i.e., the ability to produce a desired result in a real-world setting), and cost (e.g., direct and indirect). It can also account for scientific, economic, environmental, cultural, and political factors that influence the intervention.

By weighing these findings and considering trade-offs, informed decisions about the intervention can be made.

First, let's scale it down to your school. Your school, of 350 students, is considering a school-wide flu prevention program. The options being considered are presented in Table 3.

Table 3: Vaccination Options and Out-of-Pocket Costs

Option	Details	Cost per student
A	FluMist Quadrivalent (Live-attenuated influenza vaccine, quadrivalent) optional to all students during gym class, promotion of everyday prevention actions to stop the spread of germs (e.g., flyers and reminders)	$23.70
B	Injection vaccine (Inactivated influenza vaccine, quadrivalent) optional to all students during gym class, promotion of everyday prevention actions to stop the spread of germs (e.g., flyers and reminders).	$15.05
C	No vaccination offered, promotion of everyday prevention actions to stop the spread of germs (e.g., flyers and reminders)	$0

Question 7. What other factors might you consider before you start your calculations?

Answer: Students should consider CDC recommendations, effectiveness of each vaccine, and other costs such as nurses to administer the vaccine and student time out of class or activities.

Seasonal Flu Costs How Much?!
Part 5

Name: _____ Date: _____

Directions: Have student volunteers read the paragraphs. The majority of Part 5 will be completed in groups. Leave enough time at the end of the class period to discuss the final three questions.

Directions: Read the information below about the flu and answer the questions when prompted.

How well the flu vaccine works (or its ability to prevent flu illness) varies substantially from season to season. The vaccine's effectiveness also can be different depending on who is being vaccinated. At least two factors play an important role in determining the likelihood that flu vaccine will protect a person from flu illness, including (1) characteristics of the person being vaccinated (e.g., age and health), and (2) the similarity or match between the predetermined flu viruses the flu vaccine is designed to protect against and the actual flu viruses spreading in the community during a given flu season. Each year, because of the lead time required to produce the vaccines, influenza experts have to *anticipate* which flu strains are likely to predominate during the coming flu season. Although they have substantial data and experience in making this prediction, another flu strain not included in the vaccine can infect the population that year. (http://www.cdc.gov/flu/about/qa/vaccineeffect.htm)

Two general types of studies are used to determine how well influenza vaccines work: randomized controlled trials and observational studies. The first type of study is called a randomized control trial (RCT). In an RCT, volunteers are assigned randomly to either a group that receives the vaccine or a group that receives a placebo (e.g., a shot of saline), and **vaccine efficacy** is measured by comparing the frequency of influenza illness between the vaccinated and the unvaccinated groups. The second type of study is called an observational study. In observational studies the study participants make their own decisions about whether or not to be vaccinated. In this type of study, **vaccine effectiveness** is measured by comparing the frequency of influenza illness between the vaccinated and unvaccinated groups. Researchers usually perform mathematical calculations to adjust for factors to make sure the groups with and without the vaccine are as similar as possible with regards to other things that might affect if they have flu or its severity. (http://www.cdc.gov/flu/professionals/vaccination/effectivenessqa.htm)

Question 8. In your own words, explain the difference between vaccine efficacy and vaccine effectiveness.

Note: Direct students to answer Question 8 on their own. Ask a few volunteers to read their answers out loud. Write a basic definition on the board for students to refer to. For example, "efficacy = controlled situation, ideal" and "effectiveness = real-world".

Answer: Vaccine efficacy refers to how well influenza vaccines work to protect against influenza infection and illness when they are used in a controlled or ideal setting. Vaccine effectiveness refers to how well influenza vaccinations work or its ability to prevent flu illness in a real-world setting when researchers have no control over those who chose to be vaccinated or not. For more information, see http://www.cdc.gov/flu/professionals/vaccination/effectivenessqa.htm.

Question 9. Why might vaccine efficacy and vaccine effectiveness vary considerably?

Note: Ask the question aloud. Direct students to discuss in pairs. After 5 minutes, ask for volunteers to answer the question. Use this opportunity to review bias.

Bias is an unintended systematic error in the way researchers select study participants, measure outcomes, or analyze data that can lead to inaccurate results.

At least three forms of bias are especially important to avoid in interpreting the results of influenza vaccine effectiveness studies, including confounding bias, selection bias, and information bias.

- **Confounding bias** occurs when the measured effect on the outcome of interest is distorted by another factor. For example, if the majority of influenza cases in a case-control study (one type of observational study) have a chronic medical condition (e.g., diabetes) that places them at a greater risk of influenza hospitalization, which makes them more likely to receive an influenza vaccine than persons without that condition, which might produce confounding bias. If this fact were not taken into account, the estimate of effectiveness might be too low because of confounding bias (that those with underlying conditions who were more likely to be hospitalized were also more likely to be vaccinated).

- **Selection bias** refers to errors introduced into a study because of differences between persons who are enrolled in a study, compared with persons who are not enrolled. For example, persons who are willing to participate in vaccine effectiveness studies might seek health care sooner, exercise more, or live healthier lifestyles than persons who do not participate in such studies and vaccination might work better among these persons. Because of this, the study results might be biased towards finding higher vaccine effectiveness among this group than in the general population. Taking into account health seeking behaviors is especially important in vaccine effectiveness studies conducted among the elderly.

- **Information bias** can occur if there are differences in the quality or accuracy of measuring vaccination or influenza status between groups of persons being compared in a study. For example, if researchers obtain information from medical records concerning vaccination for persons with influenza, but use verbal interviews to find out if persons without influenza were vaccinated, this difference in data collection methods might bias the results of the study by giving more accurate information regarding persons with influenza.

Source: CDC. Flu Vaccine Effectiveness: Questions and Answers for Health Professionals. Available at: http://www.cdc.gov/flu/professionals/vaccination/effectivenessqa.htm

Answer is provided on the next page.

Answer: Vaccine efficacy refers to the vaccine effects that occur under ideal conditions while vaccine effectiveness is a measure of how well influenza vaccines work to protect against influenza infection and illness when they are used in real-world circumstances.

They may vary considerably because there are variable factors involved in vaccination (e.g., decision to be vaccinated) that vaccine efficacy does not account for. In many studies of vaccine efficacy, randomized, controlled conditions are established where individuals are randomly assigned to either a group that is given influenza vaccine or to a second group that is not given influenza vaccine, but instead, given a placebo. In this type of trial, researchers minimize bias.

For example, vaccine allocation is usually double-blinded, which means neither the study volunteers nor the researchers know if a given person has received vaccine or placebo. In observational studies of vaccine effectiveness, researchers might compare the percentage reduction in the frequency of influenza infections among persons vaccinated, compared with the frequency among those who were not vaccinated, assuming that the vaccine is the cause of this reduction. These studies are conducted in community settings, and researchers have no control over those who choose to be vaccinated or not, which can increase bias.

Source: CDC. Flu Vaccine Effectiveness: Questions and Answers for Health Professionals. Available at: http://www.cdc.gov/flu/professionals/vaccination/effectivenessqa.htm

Both FluMist Quadrivalent (live-attenuated influenza vaccine, quadrivalent) and an injection vaccine (inactivated influenza vaccine, quadrivalent) have generally been found to be around 50%–60% effective, on average.

Question 10. If RTCs of FluMist performed in the past had a vaccine efficacy of 62%, and observational studies done in a particular year showed an effectiveness of 59%, what could you say about the similarity or match between the flu viruses and the flu vaccine in this particular year?

Note: Rearrange students into their groups from Day 1 to compete Part 5.

Answer: The effectiveness of 59% indicates that this flu vaccine was likely a good match.

During the 2013–14 flu season, vaccine effectiveness was estimated at 51% for all ages[7] and 56% for children aged 5–19 years[8]. Thus, influenza vaccine reduced the risk for having to go to the doctor for confirmed influenza by 51% across all ages and by 56% for those in your age group. Of those aged 5–19 years, 51% were vaccinated. During 2013–2014, it was estimated that 6.6% of all students aged 5–19 years old had the flu, with approximately 0.27% of patients being hospitalized for the flu and 50% of patients being attended by a doctor.[9]

Question 11: On the basis of the 2013–14 flu season, in your school of 350 students, how many students will get vaccinated? How accurate do you think this calculation is?

Answer: Approximately 178 students (0.51 x 350 = 178 students) would get vaccinated. Answers will vary on the accuracy of this calculation. The majority students are expected to indicate that it is an underestimate.

Question 12: List reasons why a student (aged <18 years) might not get the flu vaccination.

Answer: Answers will vary. Certain reasons that persons do not get the flu vaccine include that their parents say other effective ways to prevent flu (e.g., hand washing) are available, they are healthy and are not worried about the flu, believe the flu vaccine can cause the flu or cause side effects, worry about vaccine ingredients, affirm that they never get the flu, believe that their immune system will be stronger if they get the flu, they do not believe in any vaccines, or say it is inconvenient to get vaccinated (e.g., cost or time).

See CDC's website on vaccine misconceptions for more information:
http://www.cdc.gov/flu/about/qa/misconceptions.htm

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[7] CDC. Seasonal Influenza Vaccine Effectiveness, 2005-2016. Available at: http://www.cdc.gov/flu/professionals/vaccination/effectiveness-studies.htm

[8] CDC. Interim estimates of 2013-14 seasonal influenza vaccine effectiveness—United States, February 2014. MMWR, 2014 Feb 21;63(7):137-42.

[9] CDC. Estimated influenza illness and hospitalizations averted by vaccination—United States 2013-14 Influenza Season. MMWR, 2014 Dec 12;63(49): 1151-1154. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6349a2.htm

Question 13. Complete Table 4 for all options.
Note: When all groups have completed their calculations, reveal the answers to Table 3 on the board.

Table 4. Vaccination program costs.

	Option A	Option B	No program
Percentage of students expected to be vaccinated	**67%**	**49%**	**21%**
Vaccine Effectiveness	**53%**	**49%**	**N/A**
Students expected to be vaccinated	**Answer:** 235 students	**Answer:** 171.50	**Answer:** 49.35
Students expected to be vaccinated, but still at risk	**Answer:** 110.45 students [.47× 235 students]	**Answer:** 87.65 students [.51 × 171.50 students]	**Answer**: 10.36 students [.21 × 49.35 students]
Students expected to be unvaccinated	**Answer:** 115 students [350 – 235 students]	**Answer:** 178.5 students [350 – 171.5 students]	**Answer:** 300.65 students [350 – 49.35 students]
Cases of flu expected (Assume 6.6% of those aged 5–19 years get the flu)	**Answer:** 14.88 cases [.066 × (115 + 110.45)]	**Answer:** 17.09 cases [.066 × (87.5 + 171.5)]	**Answer:** 20.52 cases [.066 × (10.36 + 300.65)]
Cases of flu averted by vaccination program	**Answer:** 5.64 cases [20.52 – 14.88]	**Answer:** 3.43 cases [20.52 – 17.09]	X
Cost to school from supplying vaccine	**Answer:** $5,569.50 (235 students × $23.50)	**Answer:** $2.581.08 (171.50 students * $15.05)	**Answer: $0**
Cost saved per case of flu averted.	**Answer:** $987.50	**Answer:** $752.50	X

The calculation used for cases of flu expected and averted is basic. To account for more complex factors, CDC researchers use modeling to predict how influenza will spread on the basis of vaccination rates and vaccine effectiveness each year. Two of the main considerations in modeling are seasonal virus transmission if no one was vaccinated versus transmission if a percentage of persons were vaccinated. This helps CDC researchers identify more closely what an outbreak on a small or large scale would look like.

Influenza viruses are spread from person to person primarily through large-particle respiratory droplets (i.e., when an infected person coughs or sneezes near a susceptible person). The typical incubation period (i.e., time from when a person contacts the virus until he or she shows symptoms) for influenza is 1–4 days (average: 2 days). The majority of healthy persons might be able to infect others beginning one day before symptoms develop and up to 5–7 days after becoming sick. Assume that a person with influenza contacts 10 persons per day and that the influenza virus is transmitted among one of every 50 contacts. This would indicate that every infected person will likely infect 1.4 other persons. (http://www.cdc.gov/flu/about/disease/spread.htm.)

Question 14. If a student has the flu, what is the likelihood that more than the expected number will become sick? In other words, is the assumption of 1.4 new cases per person on the basis of 10 contacts per day reasonable? Explain how this will affect your calculations in Question 11. (Hint: How many contacts does a student at your school typically have per day, compared with the estimated number?)

Answer: Answers will vary. Students should conclude that the number is likely an underestimate of how many students will get sick. Because students are in close contact with more than 10 students per day, the numbers will be higher. With more students sick, the costs (direct and indirect) will increase.

Question 15. Consider the scenario. If the vaccine were offered in school, 49% of students would get the vaccine if it were the injection and 67% would get the vaccine if it were the nasal spray. If the vaccine were not offered in school, only 21% would get the vaccine. How does this influence your choice of options? What type of cost would you consider this to be?

Answer: Answers will vary. Students should focus on the personal, social, and cultural aspects of getting vaccinated. Access to the vaccine is an important factor. In this case, the percentage of students willing to get vaccinated, if it is available at school, more than doubles. A peer pressure factor in receiving the vaccine if the vaccination program and getting the vaccine is considered cool might be a consideration. The type of vaccine matters as well. Approximately 20% more students were willing to get the nasal spray vaccine than the injection vaccine. This might influence the student choice toward option A. Although CDC does not necessarily recommend one over the other on the basis of scientific evidence, the social influences at school might affect a student's decision to get vaccinated. These social costs would be indirect costs. For example, if more students decide to get vaccinated because they are more comfortable with the spray than the injection, then indirect costs decrease.

Question 16. In the first parts of this exercise, you calculated certain direct and indirect costs to you and your family. On the basis of your findings, what option would you choose and why?

Answer: Answers will vary. Students should provide evidence to support their decision.

Note: Regroup for a class discussion with approximately 5–10 minutes remaining. Pose Questions 14–16 to the class. Ask for volunteers to share their responses. Assign homework and use as an assessment.

Homework: Develop a 1–2 page proposal for your school to start a vaccination program. Present the information from your cost analysis to advocate for the best option. Be sure to consider both direct and indirect costs. Explain that students will be asked to present their statements to the class during the following class period.