

Disease Detectives Division C Event

**2014 National Science Olympiad Tournament
University of Central Florida
Orlando, Florida
May 17, 2014**

Developed by
Centers for Disease Control and Prevention (CDC)
U.S. Department of Health and Human Services



Acknowledgements

This scenario presented in this Disease Detectives event is hypothetical. To the best of our knowledge, there was no outbreak of asthma in Orlando during spring of 2012. It is adapted from a case-study (given as a reference) based on an actual outbreak in Barcelona, Spain. The event was developed by CDC subject matter expert:

Michael King, Ph.D.

and

Ralph Cordell, Ph.D.

Epidemiologists

Division of Scientific Education and Professional Development
Center for Surveillance, Epidemiology, and Laboratory Services

Scientific and editorial review was provided by Ralph Cordell, Ph.D. and Kelly Cordeira, M.P.H. from Career Paths to Public Health, Division of Scientific Education and Professional Development, Center for Surveillance, Epidemiology, and Laboratory Services, Office of Public Health Scientific Services.

Suggested citation

Centers for Disease Control and Prevention (CDC). Disease Detectives Event—2014 National Tournament. Atlanta, GA. Available at: <http://www.cdc.gov/diseasedetectives/>.

Contact Information

Please send questions and comments to scienceambassador@cdc.gov.

Disclaimers

This Disease Detectives Event is in the public domain and may be used without restriction. Citation as to source, however, is appreciated.

Links to nonfederal organizations are provided solely as a service to our users. These links do not constitute an endorsement of these organizations nor their programs by the Centers for Disease Control and Prevention (CDC) or the federal government, and none should be inferred. CDC is not responsible for the content contained at these sites. URL addresses listed were current as of the date of publication.

Use of trade names and commercial sources is for identification only and does not imply endorsement by the Division of Scientific Education and Professional Development, Center for Surveillance, Epidemiology, and Laboratory Services, CDC, the Public Health Service, or the U.S. Department of Health and Human Services.

The findings and conclusions in this Disease Detectives Event are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC).

Division C 2014

Part A: Asthma Outbreak After the Science Olympiad

In May 2012, the University of Central Florida (UCF) hosted the National Science Olympiad. UCF, the second-largest university campus by enrollment in the United States, is located in Orlando, Florida, which has a population of nearly 250,000 people. During the last week of May, after the competition, physicians from a hospital near UCF contacted the Florida Department of Health (FDOH) to report an increase in persons seeking care for acute asthma symptoms. Specifically, on May 16, 100 children (younger than age 18 years) and 32 adults sought care for sudden, severe breathing difficulty at a local emergency department (ED). Multiple persons were hospitalized, and two died. FDOH contacted the Centers for Disease Control and Prevention, Epidemic Intelligence Service (EIS) and asked that they assign an EIS officer to help investigate.

Asthma is a common chronic respiratory disease in the United States. Sources reported approximately 7 million children and 18 million adults as having asthma during 2010. Asthma is characterized by episodes of airflow obstruction; symptoms include wheezing, coughing, and shortness of breath, which can be triggered by environmental factor exposures. Respiratory infections, exercise, airborne allergens (e.g., pollen, mold, animal dander, dust mites, or cockroach allergens), occupational exposures (e.g., chemicals or dusts), and airborne irritants (e.g., tobacco smoke) are some of the factors that can make symptoms worse. The key to managing asthma is to control symptoms by using correct medication, avoiding exposure to factors that make symptoms worse, and seeking health care when symptoms are not manageable.

1. (6 points) Give the definition for public health surveillance.

Before deploying a team, the Disease Detectives had to determine whether this was a large but not unusual number of cases, or a large and unusual number of cases. They used available surveillance data from Orlando, compared with data for the state of Florida (Table 1).

2. (15 points) By using the data in Table 1, provide the correct values for each lettered cell (A, B, C, D, E, and F). The data for Orlando are based on a single day and data for Florida are for the entire month. Show your work and express rates with units.

Table 1: Estimated number of emergency department (ED) visits for asthma by age group, for May 2012— Orlando and Florida.

Age (yrs)	Orlando			Florida		
	No. of ED Visits (May 16 Only)	Population	Rate (per 100K/day)	No. of ED Visits	Population	Rate (per 100K/month)
0–17	A	52,408	D	3,978	4,057,357	98.0
≥18	B	197,154	16.2	4,676	15,263,392	F
Total	C	249,562	E	8,654	19,320,749	44.8

3. (2 points) Which of the cells (A–F) that you calculated values for, represent(s) cause-specific rates? (Enter the letter for the cell(s).)

4. (2 points) Which of the cells (A–F) that you calculated values for, represent(s) age-specific rates? (Enter the letter for the cell(s).)

5. (5 points) The rates for Orlando are expressed as emergency department (ED) visits for asthma /100,000 persons/day while those for Florida are expressed as ED visits for asthma /100,000 persons/month. Because of this difference in measurement, they are not directly comparable. Make the overall rates comparable and calculate the overall relative risk of ED visits for asthma among Orlando residents, compared with Florida residents. Show your work. (Note: May has 31 days.)

6. (1 point) On the basis of the differences in the age-specific rates, among which group might an outbreak be expected?

7. (3 points) Circle three reasons why is it important for Disease Detectives to confirm that an event is unusual before proceeding with the next step. (Select all that apply)

- a. To be sure that they are dealing with a real problem.**
- b. To be sure that their research papers are published after the investigation.**
- c. To make the most efficient use of limited resources.**
- d. To support the need for additional public health funding and resources.**
- e. To respond to public concerns.**

The news media in Florida began referring to this event as an asthma epidemic. In contrast, the Disease Detectives considered this to be an asthma cluster and began planning their investigation.

8. (3 points) In the space provided on the answer key, give three reasons why the problem of ED visits for asthma should be investigated.

On the basis of the analysis of public health surveillance data, a Disease Detective team was deployed to Florida to provide epidemiologic assistance to the FDOH. The team visited three hospitals near UCF. ED records were reviewed to determine whether additional asthma cases were involved and to confirm that each ED visit was associated with a doctor's diagnosis of asthma.

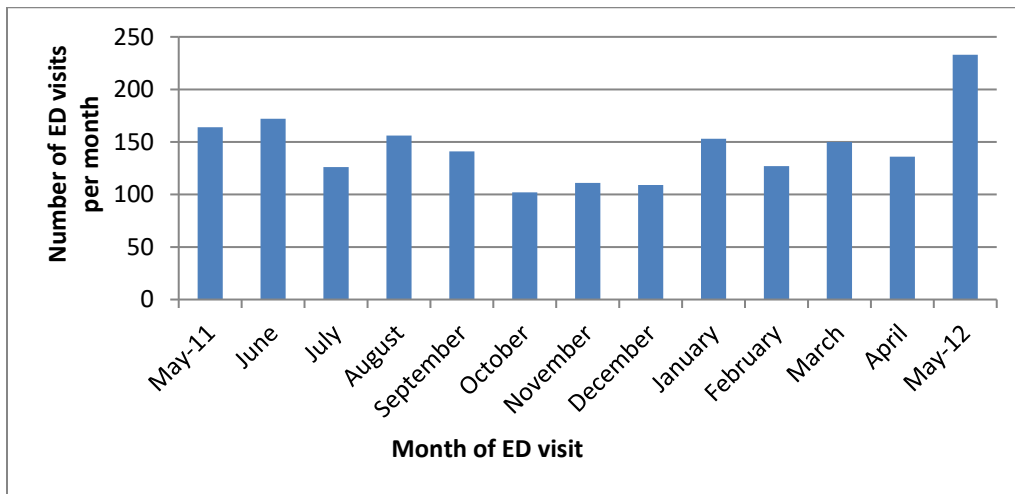
9. (4 points) Disease Detectives frequently use a case definition to identify persons with disease or health conditions in an epidemiologic investigation. List the four basic elements of a case definition.

10. (4 points) Develop a case definition for this investigation.

11. (2 points) The review of ED records from three hospitals revealed that 233 children and adults were treated for asthma during May. Is this enough information to determine whether an outbreak exists? Explain your answer.

The team collected data regarding the number of ED visits for asthma in each of the three hospitals for each month during May 2011–May 2012 (Figure 1).

Figure 1: Total number of visits for asthma at three emergency departments, in Orlando, Florida, by month of visit, during May 2011–May 2012



12. (2 points) What two pieces of important information does Figure 1 provide?

13. (2 points) Do you have enough information to determine whether an outbreak of asthma exists? Explain your answer.

Table 2: Number of asthma cases at three Orlando, Florida, EDs during May 2012, by day

Day	1	2	3	4	5	6	7	8	9	10	11
No. Cases	2	4	6	7	9	4	0	4	4	8	6
Day	12	13	14	15	16	17	18	19	20	21	22
No. Cases	7	0	2	16	103	10	2	5	5	3	4
Day	23	24	25	26	27	28	29	30	31		
No. Cases	7	5	4	2	0	2	4	2	1		

14. (1 point) Disease Detectives often use data, such as displayed with Table 2, to create a histogram or bar chart to visualize cases over time. What is the common name of this histogram or bar chart?

15. (2 points) Which of the following characteristics are most often obtained or extrapolated from or supported by the histogram in Question 14? (Select all that apply.)

- a. Time of exposure.
- b. Source of exposure.
- c. Characteristics of patients.
- d. Mode of transmission.

16. (4 points) Data in Table 2 show a sharp increase (spike) in reported cases on May 16. Give two possible explanations for this increase.

17. (6 points) Name the three categories of information regarding cases that Disease Detectives use when applying principles of descriptive epidemiology. Give a specific example of each for this investigation.

Information category	Specific example

Table 3: Patients treated for asthma in an emergency department on May 16,
by age, sex, and symptom onset time*

Age	Sex	Symptom Onset Time	Age	Sex	Symptom Onset Time	Age	Sex	Symptom Onset Time
45	M	1100	16	M	1300	15	F	1600
14	M	1600	15	F	1100	15	M	1300
14	F	1500	14	F	1100	13	F	1300
16	F	1500	43	M	1400	14	M	1300
65	M	1500	13	M	1200	19	F	2300
13	M	1100	16	F	1100	5	F	1300
13	F	1100	11	M	1100	12	F	1400
15	M	1000	13	M	1200	15	F	1400
14	M	1000	14	F	1200	12	F	900
20	F	1100	15	F	1200	13	F	900
14	M	1500	14	F	1200	12	M	1100
12	M	1500	19	F	1200	21	F	1200
46	M	1200	50	M	1100	5	M	1000
14	F	1100	11	F	1100	11	F	1000
14	M	1100	10	M	1100	13	M	1200
15	M	1100	5	F	1100	10	M	1200
17	M	1100	12	M	1100	11	F	1200
14	M	1500	19	F	1100	14	F	1000
15	M	1600	50	M	1200	11	M	1100
15	M	1600	12	F	1200	10	F	1100
6	F	1100	14	M	1200	11	F	1100
12	F	1500	15	F	1200	16	F	800
14	M	1100	13	F	1300	13	M	1300
35	M	1200	34	F	1000	13	F	1500
11	F	1700	12	M	1000	24	F	1500
14	M	1000	15	M	900	12	M	1200
15	F	1100	14	M	1500	13	M	1200
15	F	800	18	F	1500	13	F	1200
23	M	1200	14	M	1500	6	F	1200
13	M	1200	15	F	1500	14	F	1500
12	F	1200	18	F	1100	11	F	1500
16	F	1800	14	F	1400	13	F	1100
13	M	2200	12	F	1100	10	F	1100
15	M	1200	11	M	1100			
17	M	1200	13	F	1100			

*Time is measured by using a 24-hour clock.

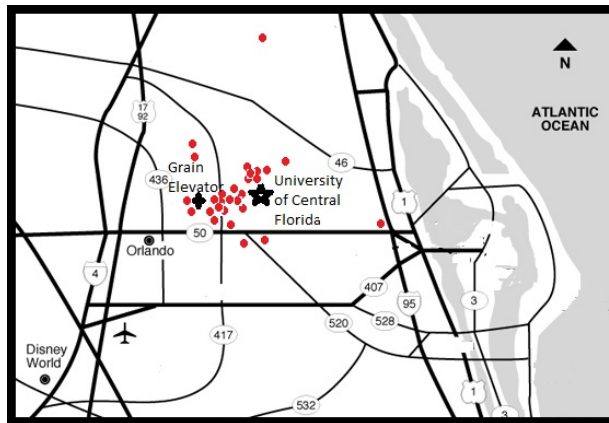
18. (2 points) The mean age of patients was 16.1 years. Name two other measures of central tendency that can be used to describe age.

19. (2 points) Calculate the proportions of males and females treated for asthma in an ED on May 16.

20. (2 points) What do these descriptive statistics indicate about the age of affected persons? The sex of those affected?

The Orlando-area map displays the geographic distribution of the onset location of asthma attacks for the 103 persons who were treated in local EDs on May 16 (Figure 2).

Figure 2: Onset location of asthma attacks, Orlando, Florida, May 16



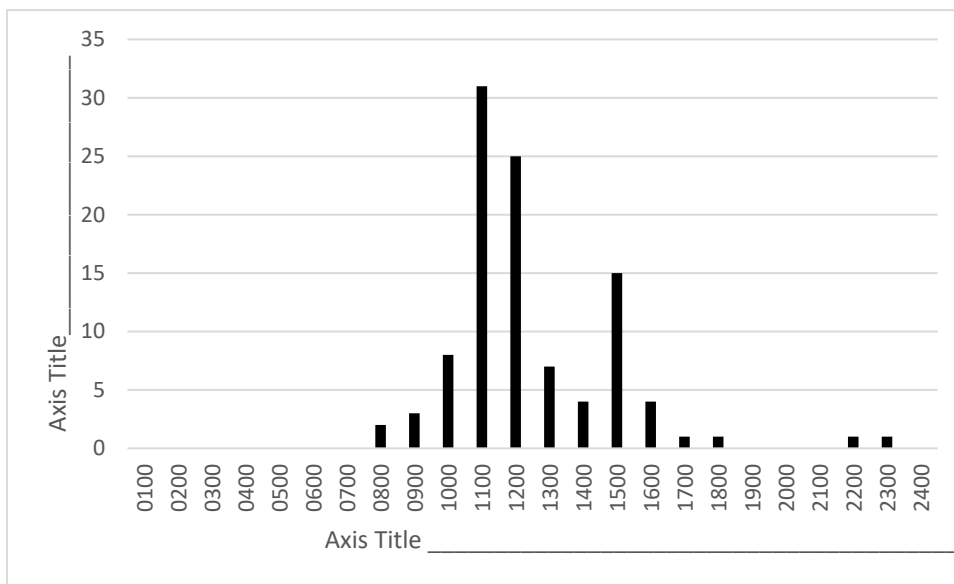
21. (2 points) What term do Disease Detectives use to refer to the type of map in Figure 2?

22. (1 point) The geographic case distribution in Figure 2 indicates which of the following hypotheses? (Select the best answer)

- a. Asthma attacks might have been associated with proximity to major roadways.
- b. Asthma attacks might have been caused by something near the water.
- c. Something might have happened near the grain elevator that caused the asthma attacks.
- d. Whatever caused the attacks was spread out evenly across all of Orlando.

On the basis of the information in Table 3, the Disease Detectives created a bar chart (Figure 3) to help visualize data patterns.

Figure 3: Asthma attacks by onset time*, Orlando, Florida, May 16



*Time is measured by using a 24-hour clock.

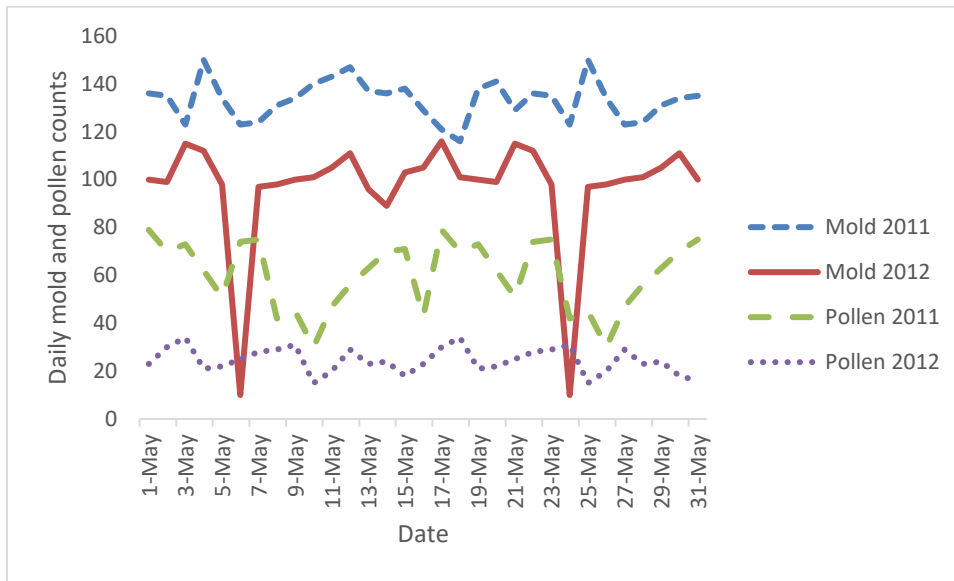
23. (2 points) Label each axis of the chart in Figure 3.

24. (1 point) Which of the following hypotheses are supported by this time distribution? (Select the best answer.)

- a. The causal exposure was continuous and ongoing.**
- b. Person-to-person transmission played a role.**
- c. The causal exposure was acute and represented a point source.**
- d. The causal exposure involved a long incubation or latency period.**
- e. None of the above.**

Because of Orlando's history of hurricane and flood damage, media speculated that mold might be the cause of the asthma epidemic. Given the potential for a seasonal component to the exposure and the clustering of asthma attacks by place and time, the team requested data regarding air pollution levels in the city during the previous 2 years. Meteorological data indicated that wind speed, precipitation, and moisture levels were low during the week of May 16. The graph in Figure 4 displays daily counts of naturally occurring airborne pollutants (pollen and mold) for Orlando during May 2011 and 2012.

Figure 4: Daily pollen and mold counts for Orlando, Florida, May 2011 and 2012



25. (1 point) What conclusion(s) about time can you draw from the information in Figure 4?

Because certain asthma patients at the Orlando EDs lived in the neighborhoods located between UCF and a large grain elevator, the Disease Detectives decided to find out more about activities at the grain elevator. The team met with officials at the elevator and learned that four products (cement, wheat, coffee, and soybeans) were loaded or unloaded in bulk from trucks or trains during the past three years, during the daytime in May. They looked at which products were loaded or unloaded during the days on which there had been increases in the number of ED visits due to asthma (i.e., “asthma outbreak days”).

Table 4: Distribution of asthma epidemic days in Orlando, Florida, by product type loaded or unloaded or not loaded or unloaded at the grain elevator

Product	Product Loaded or Unloaded		Product Not Loaded or Unloaded	
	Asthma Outbreak Days		Asthma Outbreak Days	
	Yes	No	Yes	No
Cement	5	150	9	461
Wheat	4	300	9	413
Coffee	2	125	11	482
Soybeans	15	259	1	478

26. (10 points) Calculate odds ratios to measure the association between having or not having an asthma outbreak day during a day when each of the above products was loaded/unloaded or not. (Show your work)

The Disease Detectives conducted an etiologic study to test the hypothesis generated by the descriptive case study and identify other potential risk factors for an ED visit for asthma. The team determined that the majority of patients tested positive for allergies to the product associated with asthma outbreak days. This product had been previously shown to be an allergen.

28. (7 Points) The following table includes a number of study design characteristics. Put an X in the column of the study design for which each characteristic applies. Certain characteristics apply to both, although others apply to neither design.

Characteristic	Study Design	
	Case Control	Cohort
Start with illness status and look for exposures		
Start with exposures and determine illness status		
Odds ratio used as measure of association		
Can go forward or backward in time		
Participants are randomly chosen for exposure		
Good for rare illnesses		
Good for rare exposures		
Relative risk used as a measure of association		

29. (1 point) Which of the following groups would you select to serve as control subjects if you were to do a case-control study among persons with asthma looking for risk factors associated with being treated in an Orlando ED for asthma during the period in question? (Select the best answer.)

- a. Residents of a local nursing home.
- b. Age-matched neighbors who had no history of asthma.
- c. Age-matched persons with asthma from Miami.
- d. Age-matched Orlando residents who had a previous history of asthma, but did not need to go to the ED during the period in question.
- e. None of the above.

30. (4 points) The Disease Detectives calculated a test of statistical significance (chi-square) for the product with the strongest association with epidemic days, with a pre-established cutoff of $p = 0.05$. The corresponding p value for the test was $p = .007$. Write a 1–2 sentence explanation for these results that you would give to the media.

31. (8 points) During similar epidemiologic investigations, Disease Detectives draw conclusions about cause-and-effect relationships that are based on multiple criteria. List four of these criteria in the table on your answer sheet. For each criterion, indicate whether and how the criterion was addressed by the information presented in this Science Olympiad problem. (Hint: You might have heard of these criteria referred to as Hill’s Criteria of Causation.)

Criterion	Was It Addressed? (Yes or No)	If Yes, How?

32. (2 points) What are two recommendations Disease Detectives would make to the City of Orlando and the local school system to help control or prevent future asthma epidemic days among children?

REFERENCES

Lancour, Karen L. (2013) Disease detectives (B&C) Training Handout. Available at www.soinc.org.

Atmospheric & Marine-Based Interdisciplinary Environmental Health Training AMBIENT. Air Module: Asthma Outbreak Exercise. Rosenstiel School of Marine and Atmospheric Science, University of Miami. Available at: <http://yyy.rsmas.miami.edu/groups/ambient/>.

Division C 2014

Part A: Asthma Outbreak After the Science Olympiad

In May 2012, the University of Central Florida (UCF) hosted the National Science Olympiad. UCF, the second-largest university campus by enrollment in the United States, is located in Orlando, Florida, which has a population of nearly 250,000 people. During the last week of May, after the competition, physicians from a hospital near UCF contacted the Florida Department of Health (FDOH) to report an increase in persons seeking care for acute asthma symptoms. Specifically, on May 16, 100 children (younger than age 18 years) and 32 adults sought care for sudden, severe breathing difficulty at a local emergency department (ED). Multiple persons were hospitalized, and two died. FDOH contacted the Centers for Disease Control and Prevention, Epidemic Intelligence Service (EIS) and asked that they assign an EIS officer to help investigate.

Asthma is a common chronic respiratory disease in the United States. Sources reported approximately 7 million children and 18 million adults as having asthma during 2010. Asthma is characterized by episodes of airflow obstruction; symptoms include wheezing, coughing, and shortness of breath, which can be triggered by environmental factor exposures. Respiratory infections, exercise, airborne allergens (e.g., pollen, mold, animal dander, dust mites, or cockroach allergens), occupational exposures (e.g., chemicals or dusts), and airborne irritants (e.g., tobacco smoke) are some of the factors that can make symptoms worse. The key to managing asthma is to control symptoms by using correct medication, avoiding exposure to factors that make symptoms worse, and seeking health care when symptoms are not manageable.

2. (6 points) Give the definition for public health surveillance.

(Answer) Public health surveillance is the ongoing, systematic, collection, analysis, interpretation, and dissemination of health data for disease control and prevention.

(Scoring guidance: Definition should include ONGOING, SYSTEMATIC COLLECTION, ANALYSIS, INTERPRETATION and DISSEMINATION of HEALTH DATA for DISEASE CONTROL AND PREVENTION or their synonyms. Subtract 1 point for each missing concept.)

Before deploying a team, the Disease Detectives had to determine whether this was a large but not unusual number of cases, or a large and unusual number of cases. They used available surveillance data from Orlando, compared with data for the state of Florida (Table 1).

2. (15 points) By using the data in Table 1, provide the correct values for each lettered cell (A, B, C, D, E, and F). The data for Orlando are based on a single day and data for Florida are for the entire month. Show your work and express rates with units.

Table 1: Estimated number of emergency department (ED) visits for asthma by age group, for May 2012—Orlando and Florida.

Age (yrs)	Orlando			Florida		
	No. of ED Visits (May 16 Only)	Population	Rate (per 100K/day)	No. of ED Visits	Population	Rate (per 100K/month)
0–17	A	52,408	D	3,978	4,057,357	98.0
≥18	B	197,154	16.2	4,676	15,263,392	F
Total	C	249,562	E	8,654	19,320,749	44.8

Answers

A. (Answer) 100 – no calculations are necessary. (1 point)

B. (Answer) 32 – no calculations are necessary. (1 point)

C. (Answer) 132 – no calculations are necessary. (1 point)

D. (Answer) Age-specific ED visit rate $(100/52,408) \times 100,000 = 190.8/100,000$ population/day). (4 points)

E. (Answer) Cause-specific ED visit rate $(132/249,562) \times 100,000 = 52.9/100,000$ /population/day). (4 points)

F. (Answer) Age-specific ED visit rate $(4676/15,263,392) \times 100,000 = 30.6/100,000$ population/month). (4 points)

(Scoring guidance: Score 1 point for each correct value. For rate calculations, add 1 additional point for (a) formula shown for rate, (b) per 100,000 or other unit with each rate, (c) statement of time [e.g., per month or during May] for a total of 4.0 points per rate calculation.)

3. (2 points) Which of the cells (A–F) that you calculated values for, represent(s) cause-specific rates? (Enter the letter for the cell(s).)

Answer: Cell E. (2 points)

4. (2 points) Which of the cells (A–F) that you calculated values for, represent(s) age-specific rates? (Enter the letter for the cell(s).)

Answers: Cells D and F. (1 point each)

5. (5 points) The rates for Orlando are expressed as emergency department (ED) visits for asthma /100,000 persons/day while those for Florida are expressed as ED visits for asthma /100,000 persons/month. Because of this difference in measurement, they are not directly comparable. Make the overall rates comparable and calculate the overall relative risk of ED visits for asthma among Orlando residents, compared with Florida residents. Show your work. (Note: May has 31 days.)

Answers

$I_{ORL} = (132 \text{ ED visits/day}) \div 249,562 \text{ persons} = 52.9 \text{ ED visits/day/100,000 persons. (1 point)}$

$I_{FL} = (8654 \text{ ED visits/month}) \div 1,932,0749 \text{ persons} = 44.8 \text{ ED visits/month/100,000 persons. (1 point)}$

$RR = I_{ORL}/I_{FL}$

$RR = (1639 \text{ ED visits/month/1,000,000}) \div (44.8 \text{ ED visits/month/1,000,000}) = 36.6 \text{ OR}$

$RR = (52.9 \text{ ED visits/day/1,000,000}) \div (1.4 \text{ ED visits/day/1,000,000}) = 36.6 \text{ (1 point)}$

(Scoring guidance: the crucial element of learning here is that both incidence rates must have the same time frame – I_{ORL} should be converted to ED visits/month or I_{FL} should be converted to ED visits/day. This is done by either multiplying or dividing the I_{ORL} or I_{FL} by 31, respectively, because May has 31 days. Doing this calculation correctly shows an understanding of incidence and relative risk and is worth 2 points. Attempts to do this will show a recognition, but not mastery and is worth 1 point.)

6. (1 point) On the basis of the differences in the age-specific rates, among which group might an outbreak be expected?

(Answer) An outbreak might be expected among persons aged ≤ 17 years. (1 point)

7. (3 points) Circle three reasons why is it important for Disease Detectives to confirm that an event is unusual before proceeding with the next step. (Select all that apply)

f. (Answer) To be sure that they are dealing with a real problem. (1 point)

g. To be sure that their research papers are published after the investigation.

h. (Answer) To make the most efficient use of limited resources. (1 point)

i. To support the need for additional public health funding and resources.

j. (Answer) To respond to public concerns. (1 point)

The news media in Florida began referring to this event as an asthma epidemic. In contrast, the Disease Detectives considered this to be an asthma cluster and began planning their investigation.

8. (3 points) In the space provided on the answer key, give three reasons why the problem of ED visits for asthma should be investigated.

Answers

1. General answers would include control and prevention, severity and risk to other persons, public, political, or legal concerns, program considerations and, learning and training opportunities.

2. Asthma-specific answers would include asthma-related ED visits and hospitalizations are indicators of uncontrolled asthma; asthma can be a life-threatening disease if not managed properly (through access to primary care physicians, preventive medicine, and health education).

(Scoring guidance: One point for any of the above general or specific answers up to 3 points. May be paraphrased. Other unique reasonable answers are acceptable)

On the basis of the analysis of public health surveillance data, a Disease Detective team was deployed to Florida to provide epidemiologic assistance to the FDOH. The team visited three hospitals near UCF. ED records were reviewed to determine whether additional asthma cases were involved and to confirm that each ED visit was associated with a doctor's diagnosis of asthma.

9. (4 points) Disease Detectives frequently use a case definition to identify persons with disease or health conditions in an epidemiologic investigation. List the four basic elements of a case definition.

(Answer) Clinical information about the disease. (1 point)

(Answer) Information about the location or place. (1 point)

(Answer) Characteristics about the persons who are affected. (1 point)

(Answer) A specification of time during which the outbreak has occurred. (1 point)

(Scoring guidance: The above or paraphrase and in any order.)

10. (4 points) Develop a case definition for this investigation.

Answer example: “We defined a case as any person with the following: (a) a doctor’s diagnosis of asthma (b) who was treated at an ED in Orlando for (c) breathing difficulties (d) during the month of May 2012.”

(Scoring guidance: Be flexible as long as each of the four elements of a case definition [clinical information, location, patient characteristics and time] are addressed, Score: 1 point for each element of a case definition.)

11. (2 points) The review of ED records from three hospitals revealed that 233 children and adults were treated for asthma during May. Is this enough information to determine whether an outbreak exists? Explain your answer.

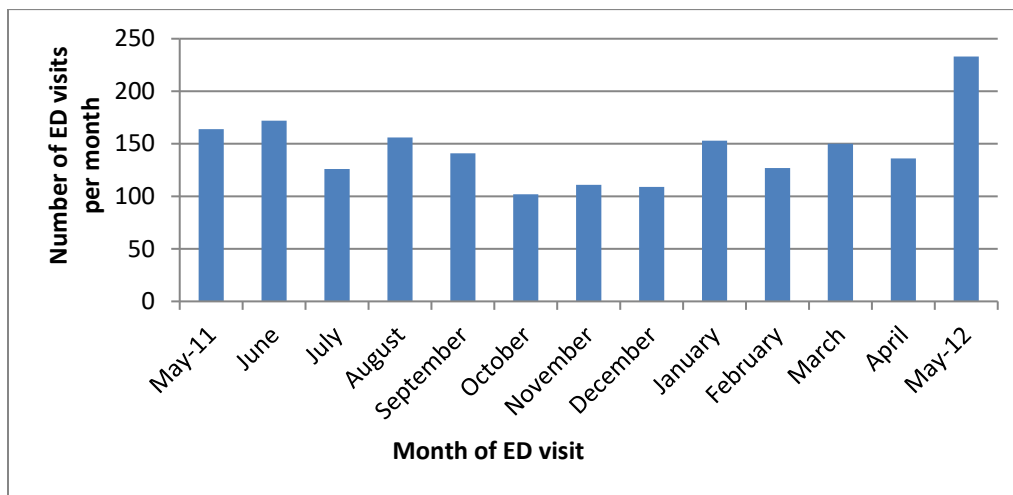
(Answer) No. (1point)

(Answer), Before calling this an outbreak we still need to know the expected number of ER visits for asthma at these hospitals for a similar period during the past. (1point)

(Scoring guidance – Bolded, underlined portion of the above is the key point. The main concept is that the outbreak includes a large area and a greater than expected number of cases.)

The team collected data regarding the number of ED visits for asthma in each of the three hospitals for each month during May 2011–May 2012 (Figure 1).

Figure 1: Total number of visits for asthma at three emergency departments, in Orlando, Florida, by month of visit, during May 2011–May 2012



12. (2 points) What two pieces of important information does Figure 1 provide?

(Answer) Baseline number of ED treatments. (1 point)

(Answer) Number of treatments on May 12 increased. (1 point)

13. (2 points) Do you have enough information to determine whether an outbreak of asthma exists? Explain your answer.

(Answer) Yes. (1 point)

(Answer) An increase above the baseline during May has been substantiated. The graph displays an unusual increase, compared with the baseline number of ED visits. (1 point)

(Scoring guidance: Accept “No” if they say that area is limited or unknown and the situation represents an outbreak.)

Table 2: Number of asthma cases at three Orlando, Florida, EDs during May 2012, by day

Day	1	2	3	4	5	6	7	8	9	10	11
No. Cases	2	4	6	7	9	4	0	4	4	8	6
Day	12	13	14	15	16	17	18	19	20	21	22
No. Cases	7	0	2	16	103	10	2	5	5	3	4
Day	23	24	25	26	27	28	29	30	31		
No. Cases	7	5	4	2	0	2	4	2	1		

14. (1 point) Disease Detectives often use data, such as displayed with Table 2, to create a histogram or bar chart to visualize cases over time. What is the common name of this histogram or bar chart?

(Answer) An epi curve or epidemic curve.

15. (2 points) Which of the following characteristics are most often obtained or extrapolated from or supported by the histogram in Question 14? (Circle all that apply.)

e. (Answer) Time of exposure. (1 point)

f. Source of exposure.

g. Characteristics of patients.

h. (Answer) Mode of transmission. (1 point)

16. (4 points) Data in Table 2 show a sharp increase (spike) in reported cases on May 16. Give two possible explanations for this increase.

(Answers)

(1) Change in numerator and the same denominator indicates a real outbreak, which means an increased rate of illness among the same population.

(2) Artifactual increases resulting from improved surveillance, publicity, false positives, or incorrect diagnoses that can create apparent numerator increases unrelated to any real change in rate of illness.

(3) Change in denominator resulting from more susceptible persons, which can lead to a change in numerator, but not an increase in rate of illness.

(Scoring guidance: 2 points per correct explanation.)

17. (6 points) Name the three categories of information regarding cases that Disease Detectives use when applying principles of descriptive epidemiology. Give a specific example of each for this investigation.

Information category	Specific example
<i>(Answer) Person (1 point)</i>	<i>(Answer) age, race, sex, occupation, and behavior (1 point)</i>
<i>(Answer) Place (1 point)</i>	<i>(Answer) residence, work place, school place, places of social activity and recreation, and travel (1 point)</i>
<i>(Answer) Time (1 point)</i>	<i>(Answer) onset date, diagnosis date, report to health authority date, and hypothesized exposure date (1 point)</i>

Scorer's guidance – must have person, place and time in column 1 (any order), accept any appropriate example for column 2.)

Table 3: Patients treated for asthma in an emergency department on May 16,
by age, sex, and symptom onset time*

Age	Sex	Symptom Onset Time	Age	Sex	Symptom Onset Time	Age	Sex	Symptom Onset Time
45	M	1100	16	M	1300	15	F	1600
14	M	1600	15	F	1100	15	M	1300
14	F	1500	14	F	1100	13	F	1300
16	F	1500	43	M	1400	14	M	1300
65	M	1500	13	M	1200	19	F	2300
13	M	1100	16	F	1100	5	F	1300
13	F	1100	11	M	1100	12	F	1400
15	M	1000	13	M	1200	15	F	1400
14	M	1000	14	F	1200	12	F	900
20	F	1100	15	F	1200	13	F	900
14	M	1500	14	F	1200	12	M	1100
12	M	1500	19	F	1200	21	F	1200
46	M	1200	50	M	1100	5	M	1000
14	F	1100	11	F	1100	11	F	1000
14	M	1100	10	M	1100	13	M	1200
15	M	1100	5	F	1100	10	M	1200
17	M	1100	12	M	1100	11	F	1200
14	M	1500	19	F	1100	14	F	1000
15	M	1600	50	M	1200	11	M	1100
15	M	1600	12	F	1200	10	F	1100
6	F	1100	14	M	1200	11	F	1100
12	F	1500	15	F	1200	16	F	800
14	M	1100	13	F	1300	13	M	1300
35	M	1200	34	F	1000	13	F	1500
11	F	1700	12	M	1000	24	F	1500
14	M	1000	15	M	900	12	M	1200
15	F	1100	14	M	1500	13	M	1200
15	F	800	18	F	1500	13	F	1200
23	M	1200	14	M	1500	6	F	1200
13	M	1200	15	F	1500	14	F	1500
12	F	1200	18	F	1100	11	F	1500
16	F	1800	14	F	1400	13	F	1100
13	M	2200	12	F	1100	10	F	1100
15	M	1200	11	M	1100			
17	M	1200	13	F	1100			

*Time is measured by using a 24-hour clock.

18. (2 points) The mean age of patients was 16.1 years. Name two other measures of central tendency that can be used to describe age.

(Answer) Median and mode – any order. (1 point each)

19. (2 points) Calculate the proportions of males and females treated for asthma in an ED on May 16.

(Answer) Proportion male = $48/103 = 46.6\%$. (1 point)

(Answer) Proportion female = $55/103 = 53.4\%$. (1 point)

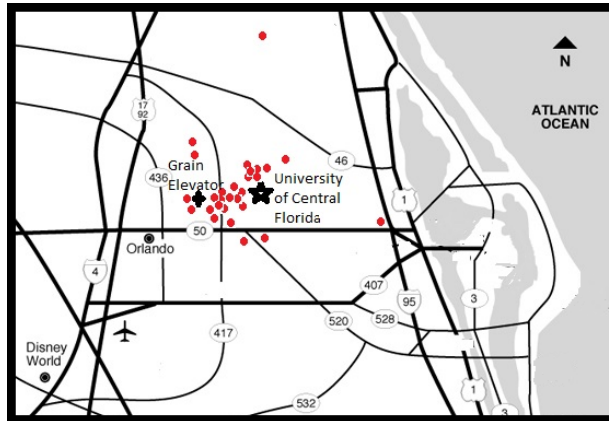
20. (2 points) What do these descriptive statistics indicate about the age of affected persons? The sex of those affected?

(Answer) Age: persons affected tended to be young. (1 point)

(Answer) Sex: approximately equal distribution between males and females. (1 point)

The Orlando-area map displays the geographic distribution of the onset location of asthma attacks for the 103 persons who were treated in local EDs on May 16 (Figure 2).

Figure 2: Onset location of asthma attacks, Orlando, Florida, May 16



21. (2 points) What term do Disease Detectives use to refer to the type of map in Figure 2?

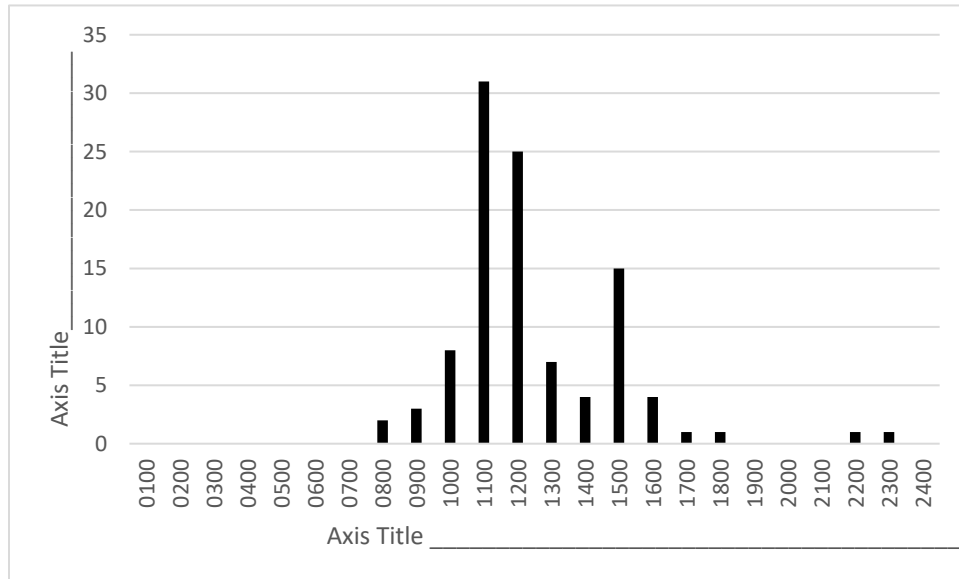
(Answer) Spot map.

22. (1 point) The geographic case distribution in Figure 2 indicates which of the following hypotheses?

- e. Asthma attacks might have been associated with proximity to major roadways.
- f. Asthma attacks might have been caused by something near the water.
- g. *(Answer) Something might have happened near the grain elevator that caused the asthma attacks.*
- h. Whatever caused the attacks was spread out evenly across all of Orlando.

On the basis of the information in Table 3, the Disease Detectives created a bar chart (Figure 3) to help visualize data patterns.

Figure 3: Asthma attacks by onset time*, Orlando, Florida, May 16



*Time is measured by using a 24-hour clock.

23. (2 points) Label each axis of the chart in Figure 3.

(Answer) X-axis is the hour of onset or onset time. (1 point)

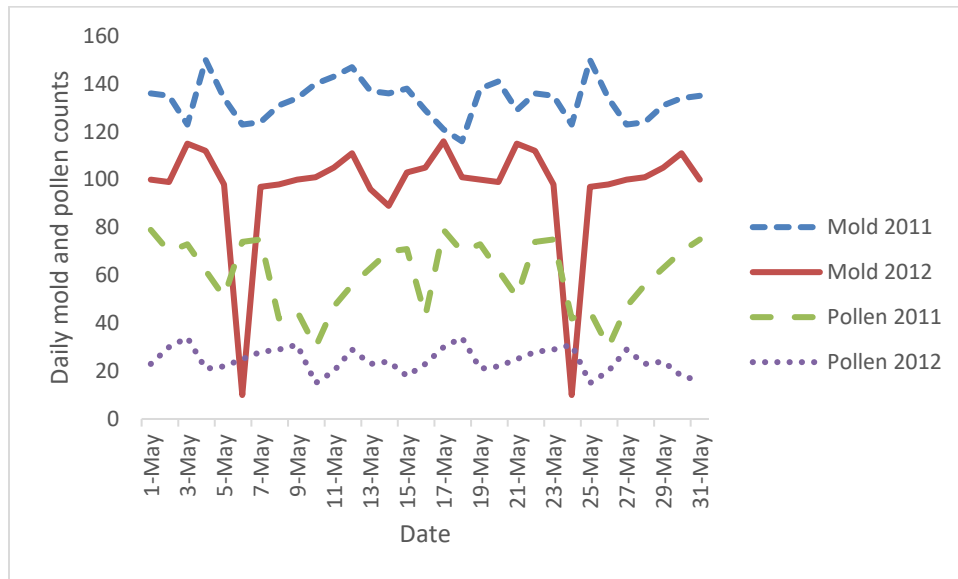
(Answer) Y-axis is the number of cases. (1 point)

24. (1 point) Which of the following hypotheses are supported by this time distribution? (Circle the best answer.)

- a. The causal exposure was continuous and ongoing.
- b. Person-to-person transmission played a role.
- c. *(Answer) The causal exposure was acute and represented a point source.*
- d. The causal exposure involved a long incubation or latency period.
- e. None of the above.

Because of Orlando's history of hurricane and flood damage, media speculated that mold might be the cause of the asthma epidemic. Given the potential for a seasonal component to the exposure and the clustering of asthma attacks by place and time, the team requested data regarding air pollution levels in the city during the previous 2 years. Meteorological data indicated that wind speed, precipitation, and moisture levels were low during the week of May 16. The graph in Figure 4 displays daily counts of naturally occurring airborne pollutants (pollen and mold) for Orlando during May 2011 and 2012.

Figure 4: Daily pollen and mold counts for Orlando, Florida, May 2011 and 2012



25. (1 point) What conclusion(s) about time can you draw from the information in Figure 4?

(Answer) During May 2012, pollen and mold levels remained well below levels for Orlando during May 2011.

Because certain asthma patients at the Orlando EDs lived in the neighborhoods located between UCF and a large grain elevator, the Disease Detectives decided to find out more about activities at the grain elevator. The team met with officials at the elevator and learned that four products (cement, wheat, coffee, and soybeans) were loaded or unloaded in bulk from trucks or trains during the past three years, during the daytime in May. They looked at which products were loaded or unloaded during the days on which there had been increases in the number of ED visits due to asthma (i.e., “asthma outbreak days”).

Table 4: Distribution of asthma epidemic days in Orlando, Florida, by product type loaded or unloaded or not loaded or unloaded at the grain elevator

Product	Product Loaded or Unloaded		Product Not Loaded or Unloaded	
	Asthma Outbreak Days		Asthma Outbreak Days	
	Yes	No	Yes	No
Cement	5	150	9	461
Wheat	4	300	9	413
Coffee	2	125	11	482
Soybeans	15	259	1	478

26. (10 points) Calculate odds ratios to measure the association between having or not having an asthma outbreak day during a day when each of the above products was loaded/unloaded or not.

Answer

Basic setup

	<i>Asthma outbreak day</i>	<i>No asthma outbreak day</i>
<i>Exposure</i>	<i>A</i>	<i>B</i>
<i>No exposure</i>	<i>C</i>	<i>D</i>

(Answer) Cement: A = 5, B = 150, C = 9, D = 461, and OR = 1.7. (2 points)

(Answer) Wheat: A = 9, B = 413, C = 4, D = 300, and OR = 1.6. (2 points)

(Answer) Coffee: A = 11, B = 482, C = 2, D = 125, and OR = 1.4. (2 points)

(Answer) Soybeans: A = 15, B = 259, C = 1, D = 478, and OR = 27.7. (2 points)

(Answer) Product(s) with the strongest association with asthma outbreak days: Soybeans (2 points).

The Disease Detectives conducted an etiologic study to test the hypothesis generated by the descriptive case study and identify other potential risk factors for an ED visit for asthma. The team determined that the majority of patients tested positive for allergies to the product associated with asthma outbreak days. This product had been previously shown to be an allergen.

28. (7 Points) The following table includes a number of study design characteristics. Put an X in the column of the study design for which each characteristic applies. Certain characteristics apply to both, although others apply to neither design.

Characteristic	Study Design	
	Case Control	Cohort
Start with illness status and look for exposures	<i>(Answer) X (1 point)</i>	
Start with exposures and determine illness status		<i>(Answer) X (1 point)</i>
Odds ratio used as measure of association	<i>(Answer) X(1 point)</i>	
Can go forward or backward in time		<i>(Answer) X (1 point)</i>
Participants are randomly chosen for exposure		
Good for rare illnesses	<i>(Answer) X(1 point)</i>	
Good for rare exposures		<i>(Answer) X (1 point)</i>
Relative risk used as a measure of association		<i>(Answer) X (1 point)</i>

29. (1 Point) Which of the following groups would you select to serve as control subjects if you were to do a case-control study among persons with asthma looking for risk factors associated with being treated in an Orlando ED for asthma during the period in question? (Select the best answer.)

- a. Residents of a local nursing home.
- b. Age-matched neighbors who had no history of asthma.
- c. Age-matched persons with asthma from Miami.
- d. *(Answer) Age-matched Orlando residents who had a previous history of asthma, but did not need to go to the ED during the period in question.*
- e. None of the above.

30. (4 points) The Disease Detectives calculated a test of statistical significance (chi-square) for the product with the strongest association with epidemic days, with a pre-established cutoff of $p = 0.05$. The corresponding p value for the test was $p = .007$. Write a 1–2 sentence explanation for these results that you would give to the media.

(Answer) The results from our investigations indicate the problem was most likely because of soybean dust generated by unloading soybeans at an area grain elevator. Asthma outbreak days had 28 times greater chance of occurring on days when soybeans were being unloaded, compared with days when soybeans were not being unloaded. The likelihood of observing this great a difference by chance was 0.7 percent or 7 out of 1000 times.

(Scorer guidance: accept paraphrasing give 1 point for trying and 1 point for addressing each of the above underlined statements.)

31. (8 points) During similar epidemiologic investigations, Disease Detectives draw conclusions about cause-and-effect relationships that are based on multiple criteria. List four of these criteria in the table on your answer sheet. For each criterion, indicate whether and how the criterion was addressed by the information presented in this Science Olympiad problem. (Hint: You might have heard of these criteria referred to as Hill’s Criteria of Causation.)

Criterion	Was It Addressed? (Yes or No)	If Yes, How?
<i>1. (Answer) Strength of the association: (1 point)</i>	<i>(Answer) Yes (0.5 point)</i>	<i>(Answer) High odds ratio and statistical significance (0.5 point)</i>
<i>2. (Answer) Temporality: (1 point)</i>	<i>(Answer) Probably Yes (0.5 point)</i>	<i>(Answer) Although the link between asthma outbreak days and exposure (loading/unloading soybeans) addresses temporality, the exposure can only be assumed to have taken place before onset of symptoms. (0.5 point)</i>

3. (Answer) <i>Dose-response:</i> (1 point)	(Answer) <i>No</i> (1 point)	
4. (Answer) <i>Consistency or coherence:</i> (1 point)	(Answer) <i>No</i> (1 point)	
5. (Answer) <i>Biologic plausibility:</i> (1 point)	(Answer) <i>Yes</i> (0.5 point)	(Answer) <i>Soy bean dust is known allergen</i> (0.5 point)
6. (Answer) <i>1-to-1 relationship:</i> (1 point)	(Answer) <i>No</i> (1 point)	

32. (2 points) What are two recommendations Disease Detectives would make to the City of Orlando and the local school system to help control or prevent future asthma epidemic days among children?

Answer

- *Install engineering controls to contain soy dust at the grain elevator.*
- *Notify local school and events when soy shipments are scheduled.*
- *Educate local medical staff and school personnel about the potential exposure and outcomes.*

(Scoring guidance: accept any reasonable recommendation (3 are listed above). Prohibiting delivery of soy products or closing the grain elevator are an unreasonable recommendation – give half credit).

REFERENCES

Lancour, Karen L. (2013) Disease detectives (B&C) Training Handout. Available at www.soinc.org.

Atmospheric & Marine-Based Interdisciplinary Environmental Health Training AMBIENT. Air Module: Asthma Outbreak Exercise. Rosenstiel School of Marine and Atmospheric Science, University of Miami. Available at: <http://rsmas.miami.edu/groups/ambient/>.