

Disease Detectives Division B 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:

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Division B 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. (1 point) Which of the following terms is defined as the ongoing, systematic collection, analysis, interpretation, and dissemination of health data for disease control and prevention? (Circle the best answer.)

- a. Epidemiology.
- b. Public health surveillance.
- c. Research epidemiology.
- d. Public health.
- e. None of the above.

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).

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 | 3978 | 4,057,357 | 98.0 |
| ≥18 | B | 197,154 | 16.2 | 4676 | 15,263,392 | F |
| Total | C | 249,562 | E | 8654 | 19,320,749 | 44.8 |

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.

- A.**
- B.**
- C.**
- D.**
- E.**
- F.**

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

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

5. (1 point) Disease Detectives compare cause-specific rates to determine whether evidence exists to support claims that this is a large number of cases. Which of the following best describes how the cause-specific rate for Orlando, compared with that for Florida? (Select the best answer.)

- a. The cause-specific rate for ED visits among Orlando residents is approximately 1.3 times greater than among Florida residents.**
- b. The cause-specific rate for ED visits among Orlando residents is 0.5–1.9 times greater than among Florida residents.**
- c. The cause-specific rate for ED visits among Orlando residents is approximately 65 times greater among Florida residents.**
- d. The cause-specific rate for ED visits among Orlando residents is approximately 35 times greater among Florida residents.**

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

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. (1 point) Which of the following is a good reason to further investigate the problem of ED visits for asthma? (Select the best answer.)

- a. Control or prevention of the health problem.**
- b. Opportunity to learn.**
- c. Public, political, or legal concerns.**
- d. Public health program considerations.**
- e. All of the above.**

On the basis of the analysis of public health surveillance data, a Disease Detectives team was deployed to Florida to provide epidemiologic assistance to 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 visit was associated with a doctor's diagnosis of asthma.

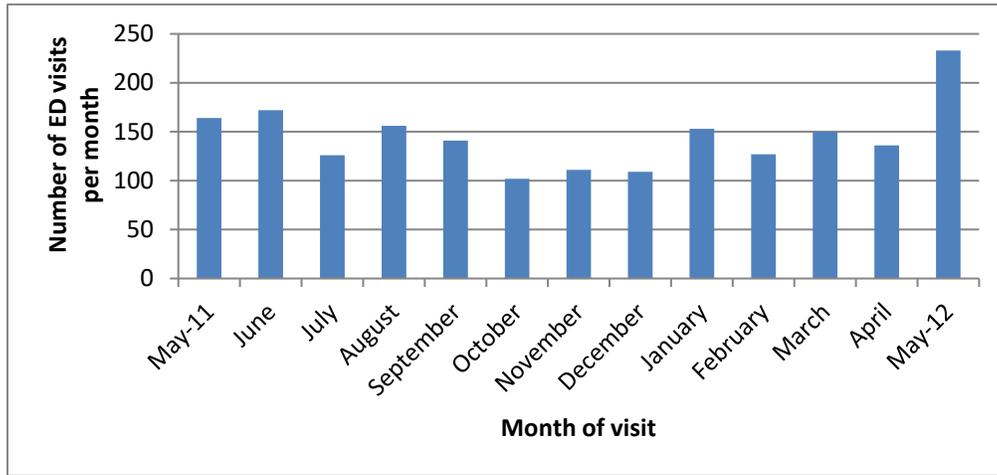
9. (4 points) Disease Detectives frequently use a case definition to identify persons with disease or health conditions in an epidemiologic investigation. List the four basic elements of a case definition.

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

11. (2 points) The review of ED records from three hospitals showed 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 hospital emergency departments 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.

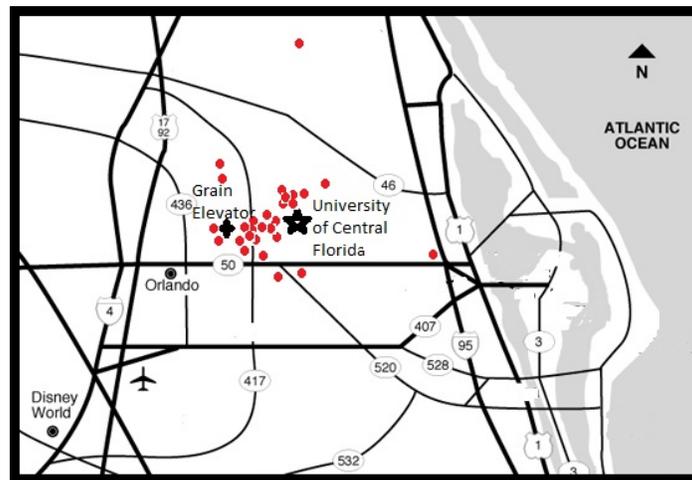
The mean patient age was 16.1 years.

18. (2 points) Calculate the proportions of males and females treated for asthma in an ED on May 16. (Show your calculations.)

19. (2 points) What do these descriptive statistics indicate about the age of those affected? 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



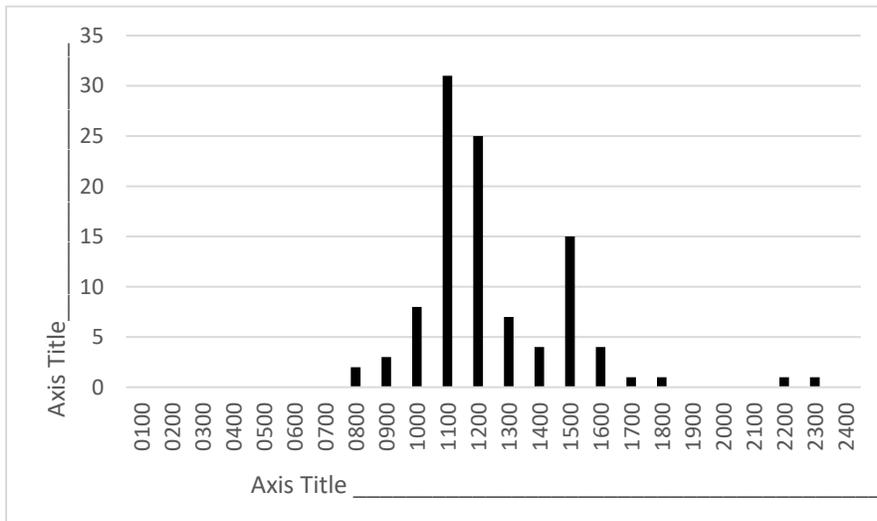
20. (2 points) What term do Disease Detectives use to refer to the type of map in Figure 2?

21. (1 point) The geographic distribution of cases in Figure 2 supports which of the following hypotheses? (Circle 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 patterns in the data.

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



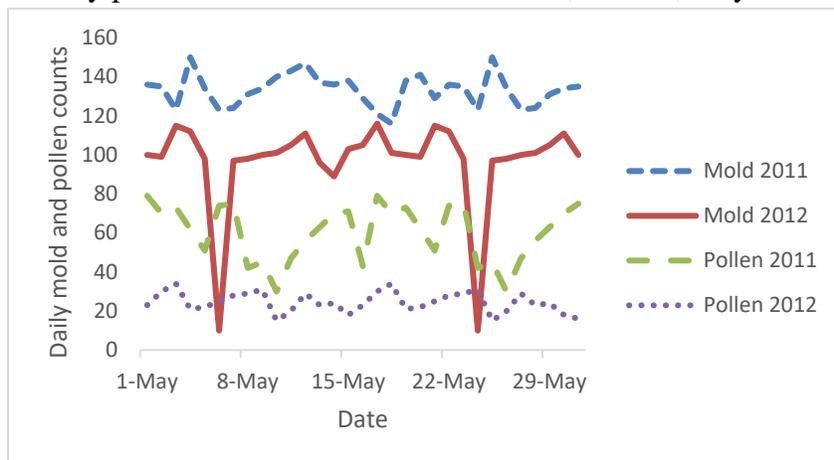
22. (2 points) Label each axis of the chart in Figure 3.

23. (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. 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 outbreak. 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 two 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



24. (1 point) Which of the following conclusions can you draw from the information in Figure 4? (Select the best answer.)

- a. Mold levels have increased from 2011 to 2012.**
- b. Pollen levels appear to be much higher than mold levels for all periods shown.**
- c. The data support an association between mold and pollen levels and ED visits for asthma.**
- d. There appear to be clear seasonal patterns to both mold and pollen levels.**
- e. None of the above.**

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 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 outbreak 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 |

25. (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.

Cement: (2 points)

Wheat: (2 points)

Coffee: (2 points)

Soybeans: (2 points)

Product(s) with the highest association with asthma outbreak days: (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.

26. (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, and 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 | | |

27. (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? (Circle 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.

28. (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? |
|-----------|----------------------------------|--------------|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

29. (4 points) What are two recommendations Disease Detectives could make to the City of Orlando and the local school system to help control or prevent future asthma outbreak days among children?

REFERENCES

Lancour, Karen L. (2013) Disease detectives (B&C) Training Handout. Available at <https://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 B 2014

Part A: Asthma Outbreak After the Science Olympiad

Answer Key

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. (1 point) Which of the following terms is defined as the ongoing, systematic collection, analysis, interpretation, and dissemination of health data for disease control and prevention? (Circle the best answer.)

- a. Epidemiology.
- b. *(Answer) Public health surveillance.*
- c. Research epidemiology.
- d. Public health.
- e. None of the above.

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 | 3978 | 4,057,357 | 98.0 |
| ≥18 | B | 197,154 | 16.2 | 4676 | 15,263,392 | F |
| Total | C | 249,562 | E | 8654 | 19,320,749 | 44.8 |

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 $(4676/15263392) \times 100,000 = 30.6/100,000$ population/month). (4 points).

(Scoring guidance: Score 1 point for each correct value. For rate calculations, give 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 points per rate calculation.)

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

(Answer) Cell E.

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

(Answer) Cells D and F. (1 point each)

5. (1 point) Disease Detectives compare cause-specific rates to determine whether evidence exists to support claims that this is a large number of cases. Which of the following best describes how the cause-specific rate for Orlando, compared with that for Florida? (Select the best answer.)

- The cause-specific rate for ED visits among Orlando residents is approximately 1.3 times greater than among Florida residents.
- The cause-specific rate for ED visits among Orlando residents is 0.5–1.9 times greater than among Florida residents.
- The cause-specific rate for ED visits among Orlando residents is approximately 65 times greater among Florida residents.
- (Answer) The cause-specific rate for ED visits among Orlando residents is approximately 35 times greater among Florida residents.

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

(Answer) An outbreak might have occurred among persons aged ≤ 17 years.

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. (1 point) Which of the following is a good reason to further investigate the problem of ED visits for asthma? (Select the best answer.)

- a. Control or prevention of the health problem.**
- b. Opportunity to learn.**
- c. Public, political, or legal concerns.**
- d. Public health program considerations.**
- e. (Answer) All of the above.*

On the basis of the analysis of public health surveillance data, a Disease Detectives team was deployed to Florida to provide epidemiologic assistance to 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 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)*
- Information about the location or place. (1 point)*
- Characteristics about the persons who are affected. (1 point)*
- 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 visited an ED in Orlando for (c) breathing difficulties (d) during 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 showed that 233 children and adults were treated for asthma during May. Is this enough information to determine whether an outbreak exists? Explain your answer.

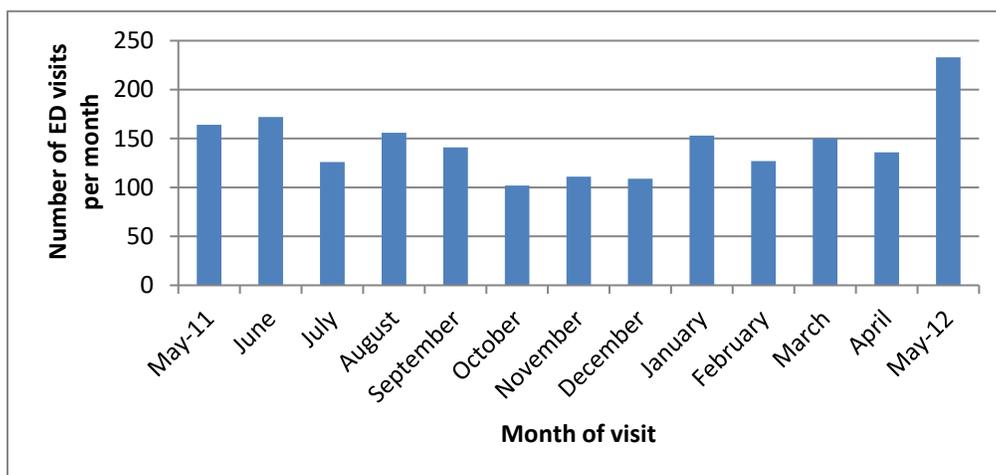
(Answer) No. (1 point)

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

(Scoring guidance: the underlined portion of the above is the key point; accept paraphrasing.)

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 visits. (1 point)

(Answer) Number of visits 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 hospital emergency departments 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. (1 point)

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, places of social activity and recreation, school place, 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.

The mean patient age was 16.1 years.

18. (2 points) Calculate the proportions of males and females treated for asthma in an ED on May 16. (Show your calculations.)

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

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

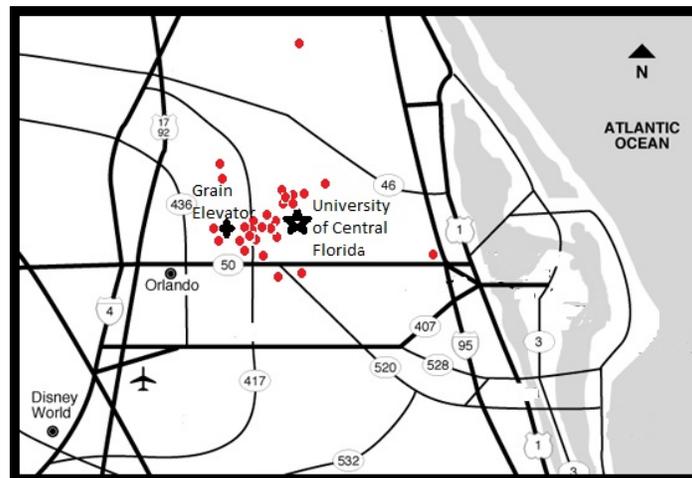
19. (2 points) What do these descriptive statistics indicate about the age of those affected? The sex of those affected?

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

(Answer) Gender: 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



20. (2 points) What term do Disease Detectives use to refer to the type of map in Figure 2?

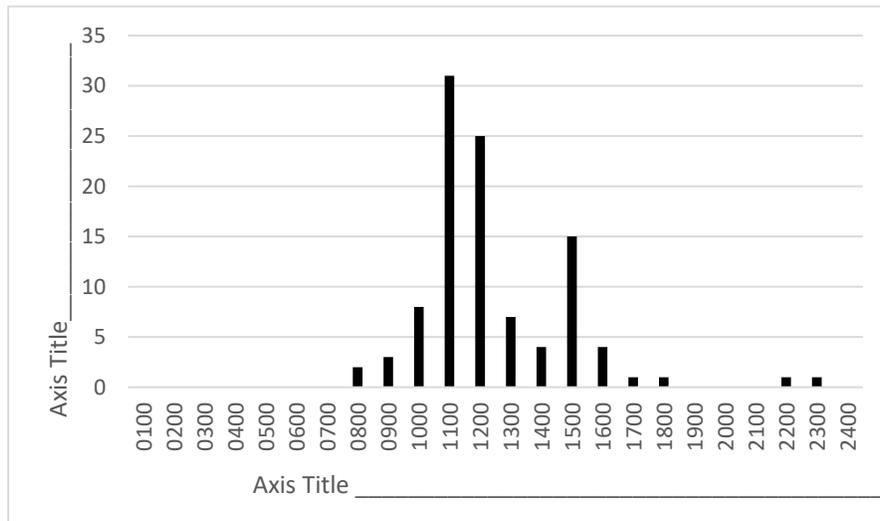
(Answer) Spot map.

21. (1 point) The geographic distribution of cases in Figure 2 supports which of the following hypotheses? (Circle the best answer.)

- 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 patterns in the data.

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



22. (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)

23. (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.

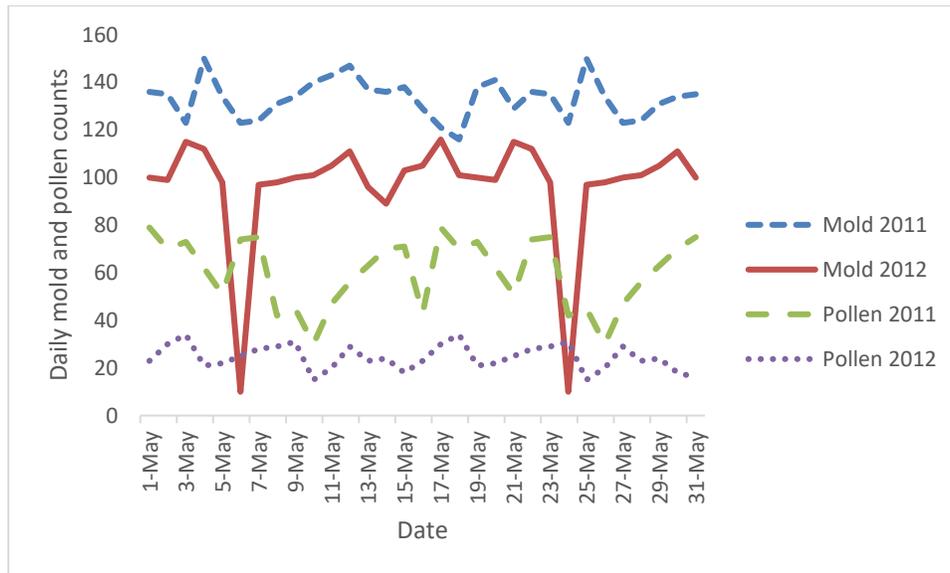
c. (Answer) The causal exposure was acute and represented a point source.

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 outbreak. 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 two 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



24. (1 point) Which of the following conclusions can you draw from the information in Figure 4? (Select the best answer.)

- a. Mold levels have increased from 2011 to 2012.
- b. Pollen levels appear to be much higher than mold levels for all periods shown.
- c. The data support an association between mold and pollen levels and ED visits for asthma.
- d. There appear to be clear seasonal patterns to both mold and pollen levels.
- e. (Answer) None of the above.

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 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 outbreak 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 |

25. (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.

Cement: (2 points)

Wheat: (2 points)

Coffee: (2 points)

Soybeans: (2 points)

Product(s) with the highest association with asthma outbreak days: (2 points).

Basic setup

| | Asthma outbreak day | No asthma outbreak day |
|-------------|---------------------|------------------------|
| Exposure | A | B |
| No exposure | C | D |

Answer

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

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

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

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

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

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.

26. (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, and 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> |

27. (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? (Circle 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.

28. (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> |
| <i>3. (Answer) Dose-response: (1 point)</i> | <i>(Answer) No (1 point)</i> | |
| <i>4. (Answer) Consistency or coherence: (1 point)</i> | <i>(Answer) No (1 point)</i> | |
| <i>5. (Answer) Biologic plausibility: (1 point)</i> | <i>(Answer) Yes (0.5 point)</i> | <i>(Answer) Soy bean dust is a known allergen (0.5 point)</i> |
| <i>6. (Answer) 1-to-1 relationship: (1 point)</i> | <i>(Answer) No (1 point)</i> | |

(Scoring guidance 1 point for each correct criterion or reasonable paraphrase, 1 point for each correct address and how)

29. (4 points) What are two recommendations Disease Detectives could make to the City of Orlando and the local school system to help control or prevent future asthma outbreak 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]. Two points for each recommendation. 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 <https://www.soinc.org>.

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