



Student Name(s) _____

School Name and State _____

Team Number _____

**DIVISION C
DISEASE DETECTIVES**

**National Science Olympiad
Wichita State University
Wichita, Kansas
May 18-19, 2007**

Developed by the
Office of Science Education
Centers for Disease Control and Prevention (CDC)

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service



This event includes 3 Problems;

Problem I: DISEASE DETECTIVES TACKLE ENVIRONMENTAL HEALTH

Total Suggested time = 10 minutes

Public perceptions of environmental health often are only that it relates to illnesses due to chemical exposures from pollution. This is only a small part of the environmental disease detectives' role. Environmental health is the promotion of health and quality of life by preventing or controlling diseases that result from interactions between people and their environment. Almost every disease could be considered to be caused by either environmental factors or genetic factors. Disease detectives consider environment very broadly. The human environment is the air we breathe, the water we drink, the food we eat, the climate surrounding us, and the space we live in.

1. (2 pts) The environment is one component of a famous triad in epidemiology. List the other two components of that triad.
 - **Agent**
 - **Host**
2. (2 pts) Individual characteristics of people, such as age, may modify the effects of environmental exposures. List 2 of these that disease detectives need to think of in planning investigations.

Answers will vary but may include

- **Genetic (genes)**
- **Diet (nutrition)**
- **Gender**
- **Physical Condition**
- **Other diseases (Underlying diseases)**

Environmental epidemiology studies often deal with specific factors which can be measured quantitatively as either an exposure or a dose. When the factor is a chemical, exposure can be estimated and dose determined by measuring the chemical in blood or tissue. For many environmental factors there may be a range of effects from subtle biochemical changes to severe illness

3. (1 pt) What is this relationship between dose and severity of illness called?
 - **Dose Response**

This relationship is important in environmental epidemiology because it can provide a foundation for safety standards that state or federal government officials can be used to decide which health effects should be prevented.

4. (1 pt) Name a U.S. government agency that might use environmental epidemiology to set air or water quality standards?
 - **Environmental Protection Agency (EPA or USEPA)**

Public environmental health problems usually are of two types: they come to our attention because concerns about illnesses, or they arise from potential exposure situations. Procedures to evaluate environmentally caused diseases follow the same basic principles as used in communicable disease studies. Some diseases caused by micro-organisms such as bacteria or viruses can also be considered environmentally related diseases.

5. (3 pts) Name 3 routes of entry into a person's body for environmental micro-organisms or chemicals .

- **Respiratory (breathing or through the air)**
- **Ingestion (food, eating, water or drinking)**
- **Dermal Contact (skin or skin absorption)**

6. (3 pts) Environmental factors that can cause disease could be biological, chemical, or physical. List one of each type. (No credit if you list agents discussed in today's event)

Answers will vary but may include

Biological:

- **Bacteria or parasites or viruses (Specific genus/species of specific organism or virus name is acceptable)**

Chemical:

- **Drugs**
- **Dust**
- **Skin irritants**
- **Food additives**
- **Food contaminants**
- **Hazardous waste**
- **Toxic waste**
- **Pollution**

Physical:

- **Noise**
- **Climate**
- **Weather**
- **Light**

Problem II. DISEASE DETECTIVES TRACK DOWN THE KILLER OF LEGIONS

Total Suggested time = 25 minutes



Fig 1. Covers from Magazines Featuring Articles on the Outbreak of Legionnaires Disease in Philadelphia, Summer 1976 (CDC Public Health Image Library)

The year 1976 marked the 200th anniversary of the signing of the Declaration of Independence and the start of a new era in public health – the era of emerging infectious diseases. There was widespread concern about the isolation of a strain of influenza virus from a soldier who died from the disease in Fort Dix, New Jersey in early February. The virus was similar to that responsible for the great pandemic in 1918 and in March President Gerald Ford announced a \$135 million plan to immunize Americans against the so-called “swine flu”. The health care and public health communities were on the alert for cases of severe respiratory illness that would suggest the start of a pandemic.

It was in this setting that the American Legion Auxillary, Department of Pennsylvania held its 56th annual convention in Philadelphia, Pennsylvania on July 21-24th. Within 2 days of the start, a number of attendees became ill with severe pneumonia – ultimately 221 persons became ill and 34 persons died of what is now known as “Legionnaires’ disease”. The first death took place on Saturday, July 24.

7. Legionnaires' disease is caused by a bacterium while influenza is caused by a virus.
 - a. (1 pt) Which of the above types of pathogen is most likely to multiply in the environment?
 - **Bacteria**
 - b. (1 pt) Which of the above diseases is most likely to be spread from person-to-person?
 - **Influenza**

By mid-day Monday, July 26th, 11 persons had died. Disease Detectives from the CDC and Pennsylvania Department of Health were notified of a possible outbreak of pneumonia among Legionnaires attending the convention in Philadelphia.

The Pennsylvania Medical Society, Pennsylvania Osteopathic Association and Hospital Association of Pennsylvania were notified of a potential statewide epidemic of pneumonia. Public health nurses searched hospitals in their areas for possible cases.

8. (24 pts) Describe two groups of cases likely to be missed by the above case-finding.

Answers will vary but may include:

- **Persons who did not seek medical attention**
- **Persons who sought medical attention outside Pennsylvania**
- **Persons who did not become ill**
- **Persons who developed symptoms other than pneumonia**

The public was invited to report possible cases via a telephone hot line and news reports were searched for additional cases and a series of at least 8 different surveys were conducted in order to identify additional cases. One of these included a survey of a random sample of guests registered in four Philadelphia hotels during the period from July 6 - August 7, 1976.

Table 1. Illness resembling Legionnaires' disease in random sample of guests in four Philadelphia hotels according to week of registration, July 6 - August 7, 1976.

Hotel	Week of Registration				
	July 6-10	July 11-17	July 18-24	July 25-31	August 1-7
A	0/142/155*	0/130/159	15/180/200	0/106/152	0/88/147
B	-	-	5/144/200	-	-
C	-	1/70/85	2/100/160	0/95/140	0/78/160
D	-	1/90/151	1/84/150	0/92/151	9/58/154

* Number ill/number interviewed/number selected for survey

9. Using the data in Table 1, calculate the relative risk of illness resembling Legionnaires' disease for each of the above 4 hotels for the week of July 18-24. (show your work in the spaces below)

a. Hotel A (2 pts)

- **Incidence = $(15/180) * 100 = 8.3$**
- **Relative Risk = $8.3/1.2 = 6.9$**

b. Hotel B (2 pts)

- **Incidence = $(5/144) * 100 = 3.5$**
- **Relative Risk = $3.4/1.2 = 2.9$**

c. Hotel C (2pts)

- **Incidence = $(2/100) * 100 = 2.0$**

- **Relative Risk = $2.0/1.2 = 1.7$**

d. Hotel D (2pts)

- **Incidence = $(1/84) * 100 = 1.2$**
- **Relative Risk = Referent Group**

Note: Hotel D serves as the referent group and serves as the denominator for calculating the relative risk for the other hotels

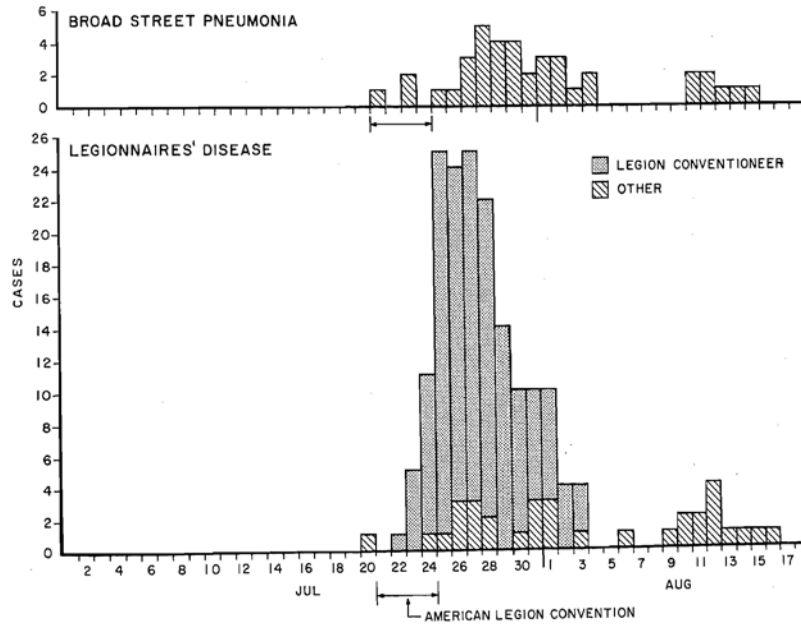


Figure 2: Number of cases of Legionnaires disease and Broad Street pneumonia by date of onset.

Figure 2 shows the number of cases of Legionnaires disease and of another condition, Broad Street pneumonia, by date of onset. Persons with Broad Street pneumonia had illness similar to the attendees of the American Legion convention. These persons did not attend the American Legion convention or enter Hotel A but were within one block of Hotel A between July 1 and the onset of their illness. Hotel A is located on Broad Street.

10. (1 pt) What term do Disease Detectives use for the graph in Figure 1?

Epidemic curve or epi curve

11. (1 pt) Based on the shape of the curve for Legionnaires' disease, what type of epidemic source (point source or person-to-person) is represented in Figure 1?

Point source

12. The Philadelphia outbreak is the second time that "Broad Street" appears in the epidemiologic literature. The first "Broad Street" is in another city/country and was associated with another disease and an outbreak that is considered to be the start of the field of epidemiology.

- a. (1 pt) Where (what city/country) was the first Broad Street?

London, England

- b. (1 pt) What was the disease under investigation in the first outbreak?

Chlorea

- c. (1 pt) Who was the person who investigated the first outbreak?

John Snow

13. (2 pts) Returning to the Philadelphia outbreak, what do these Broad Street pneumonia cases tell you about the possible exposures to the agent and the risk for disease?

The source of exposure was associated with the hotel, but illness was not confined to people who only stayed at the hotel

Disease detectives conducted a number of investigations on the possible mode of transmission. One of these included an interview of 59 persons who were roommates of Legionnaires' disease case patients while they were at the convention and 69 roommates of 68 control Legionnaires. Five of the 59 roommates of Legionnaires' disease cases and 5 of 69 roommates of controls were ill with Legionnaires' disease.

14. (2 pts) Calculate the relative risk of illness among roommates of Legionnaires' disease cases (show your work in the space below)

Relative Risk = (5/59)/(6/69) = 0.97

On August 17, 24 days after the end of the convention, disease detectives interviewed 193 family contacts of persons with Legionnaires disease and 209 family contacts of well attendees. None of these persons had Legionnaires-like illness after the convention.

15. (1 pt) What does this suggest about the likelihood of person-to-person transmission?

Person to person transmission from these cases is not very likely.

Five months after the outbreak, disease detectives interviewed 56 Legionnaires who became ill and survived their illness and 56 control persons, matched with the cases by age, who had not become ill. One of the questions asked dealt with smoking at the convention. The results of that investigation are shown in Table 2.

Table 2 History of cigarette smoking among Legionnaires' disease among matched case and control pairs at the American Legion Convention, Philadelphia, July, 1976

Cases	Controls		Total
	Smoker	Nonsmoker	
Smoker	14	17	31
Nonsmoker	5	16	21
	19	33	52

16. (1 pt) What term do Disease Detectives use for the study design?

Matched case-control study

17. (4 pts) Calculate the odds ratio or relative risk (whichever is appropriate) for illness associated with smoking at the convention (Show your work in the space below – carry answer to 2 decimal places).

Max likelihood = $17/5 = 3.4$

Investigations of 28 area restaurants and bars and the two main Legionnaires events where food was served failed to demonstrate an association between illness and food consumption. Disease detectives studied the association between alcohol or water consumption and illness. Although no association was found between alcohol consumption and illness, 45 of 69 ill delegates drank water as compared to 469 of 976 well delegates.

18. (2 pts) Calculate the odds ratio of illness associated with water consumption. (Show your work in the space below).

Odds Ratio = $(45 * 507)/(24 * 469) = 2.02$

**Problem II. DISEASE DETECTIVES INVESTIGATE AN OUTBREAK OF
ACCIDENTAL POISONING**

Total Suggested time = 15 minutes



Acute renal failure is a serious medical condition in which the kidneys (the organ responsible for eliminating toxic substances from the body) either function poorly or not at all. The condition is life threatening without prompt medical attention. Acute renal failure can be due to underlying illnesses, or can be caused by infections or ingesting certain chemicals. Kidney function can be assessed by measuring the level of a creatinine in a patient's blood. Levels of 1.5 mg/dl (milligrams per deciliter) or higher indicate impaired kidney function.

In September 2006, a physician at a hospital in the Republic of Panama reported to health officials that he had noticed an unusual number of older men that all developed unexplained, new-onset acute renal failure as well as some different neurological symptoms. Upon reviewing some of the hospital's medical charts and records, health care officials noticed that a few persons with these symptoms actually had presented to the hospital as far back as June of 2006. Some patients complained of different types of gastrointestinal symptoms such as nausea, stomach pain, and/or diarrhea when they first presented to the hospital. These symptoms were either accompanied by or followed very shortly thereafter in all cases by oliguria or anuria (decreased or absent urine production). Loss of appetite and fatigue were also found among many of the patients. Many patients also typically developed unusual neurological signs a few days later. These were variable between patients and included weakness in the muscles of the face, weakness of the arms and legs, and encephalopathy (severe confusion and inability to respond). Twelve (57%) of twenty-one patients had died. Patients presenting to this hospital with these symptoms typically had creatinine levels of 10 mg/dl or higher. About two months before the outbreak, the hospital system added the new drug lisinopril for hypertension to its pharmacy. Physicians noticed that some of the sick patients had been taking this new drug. One side effect of this type of

medication is a dry cough. Some patients brought their medications with them to the hospital, which included bottles of a prescription cough syrup. Health authorities suspected that contamination of one of these medications may have been causing the illness.

1. (2 pts) List two sources of information investigators could use to identify additional cases of acute renal failure in this community?

Answers will vary but may include

- Hospital admission data from other hospitals
 - Hemodialysis clinics
 - Private nephrologists (kidney physician specialist) offices
 - Local public health authorities
 - Outpatient clinics
 - Local health departments
 - Regional epidemiologists
 - Private doctors
2. (2 pts) How could investigators show that this was an unusual occurrence for this hospital?
 - **Compare incidence of new onset acute renal failure in the population to national, historical normal rates as well as rates diagnosed at comparable local hospitals**
 - **Review records and compare current information to historical information**

Investigators identified a total of 42 cases of acute renal failure and designed a matched case-control study utilizing patients within the hospital.

3. (4 pts) Write a concise and specific case definition for the case- control study.
 - **Unexplained acute renal failure in a person occurring in June 2006 or later with oliguria/anuria and creatinine ≥ 1.5 mg/dL**
4. (2 pts) Explain briefly why investigators matched controls to cases by gender.
 - **Most cases were men**
 - **Statistical efficiency**

Note: No credit for

- **To study gender-specific associations**
- **To control confounding**

5. (2 pts) Besides the possible exposures already identified, name two other possible exposures you would want to include in your questionnaire.

Answers will vary but may include

- **Other medications including over the counter products and folk remedies**
- **Social habits (i.e. smoking, alcoholic beverages, recreational activities that might identify a sub-group with a particular exposure)**
- **Dietary patterns including water source**
- **Additional medications**
- **Possible infectious exposures (food, animals)**
- **Pesticides**
- **Tobacco**

A total of 42 case-patients and 140 control-patients were enrolled in the case-case control study. Date of onset of acute renal failure for case-patients is shown below.

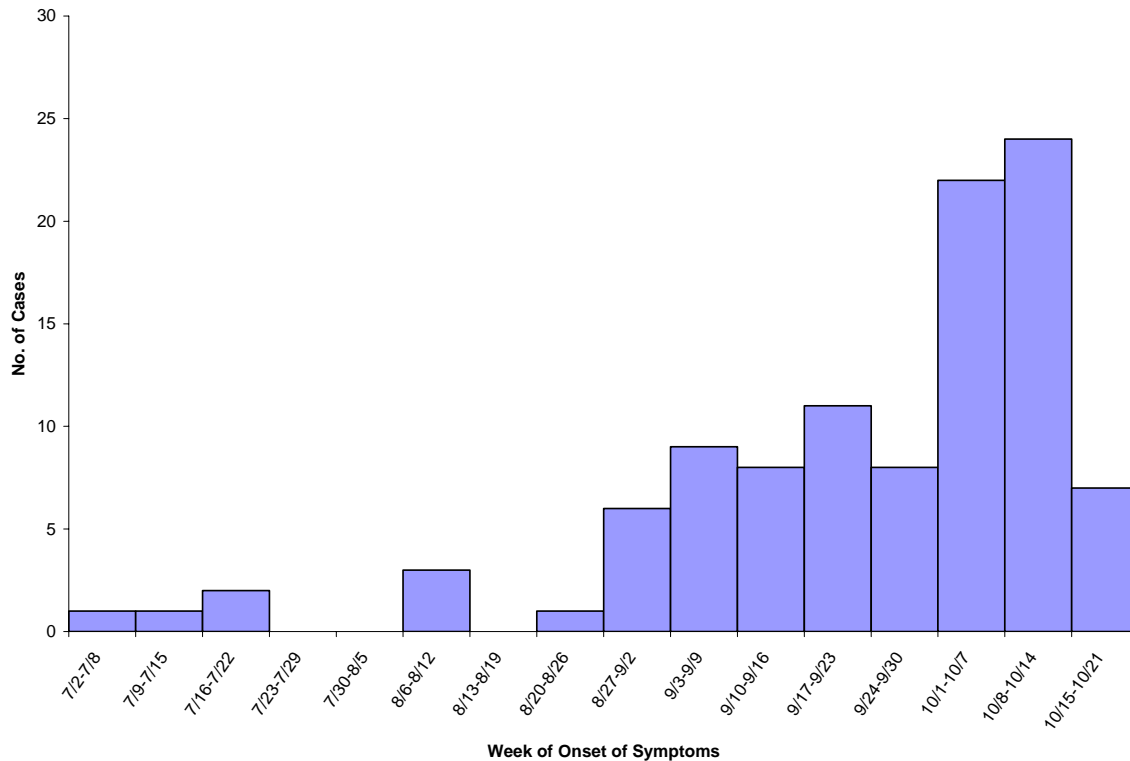


Figure 1. Number of cases of acute renal failure in Panama, by week of onset of symptoms, July 2 through October 21, 2006.

6. (1 pt) What do disease detectives call this type of histogram?

Epidemic curve (epi curve)

Table 1. Associations between potential risk factors and onset of acute renal failure syndrome among case- and control-patients, Panama, 2006.

	Cases (n=42)		Controls (n=140)	
	No.	%	No.	%
<i>Used cough syrup</i>				
<i>yes</i>	17	40.5	4	2.9
<i>no</i>	25	59.5	136	97.1
<i>Used any ACE inhibitor</i>				
<i>yes</i>	26	61.9	34	24.3
<i>no</i>	16	38.1	106	75.7

7. (4 pts) Calculate odds ratios for use of cough syrup and ACE inhibitors. Show all work.

Cough Syrup:

Odds Ratio: $(17 * 136)/(25 * 4) = 23.12$

Used any ACE inhibitor:

Odds Ratio: $(26 * 106)/(16 * 34) = 5.07$

8. (2 pts) What proportion of cases used both cough syrup and any ACE inhibitors?

Cannot determine from data provided

The CDC environmental health laboratory analyzed medications provided by case-subjects for the presence of contaminants and identified the presence of diethylene glycol, or DEG, in the cough syrup. DEG is known to be toxic to the renal system and can cause acute renal failure.

9. (4 pts) In light of the laboratory findings, explain the role each of these medications played in the exposure-disease relationship.

Both the odds ratios are elevated, however, the cough syrup is extremely high and was validated as being contaminated by the lab. It is likely that the elevated odds ration for e thecae inhibitors is due to the fact that those using ace inhibitors were also using the cough syrup because we know lisinopril causes a dry, irritating cough. (see case introduction) So although the lisinopril is causative, it is only through its association with the cough syrup. In other words, ace inhibitors confounded the exposure-disease relationship.

Investigators informed health officials of these findings. The cough syrup was manufactured by a local Panamanian pharmaceutical company which used glycerin as one ingredient in its cough syrups. Further laboratory work identified DEG in a single lot of glycerin that had been imported to Panama from China.

10. (1 pt) Describe an immediate intervention that health officials would most likely have done based on this new information.

Answers will vary but may include

- **National medication recall of all suspected contaminated medication**
- **Shut down the manufacturing facility**
- **Recall the cough syrup through public announcement on the radio, in newspapers, etc.**

An outbreak similar to this occurred in United States in 1937, in which 105 people died. This led to the passage of the 1938 Federal Food, Drug, and Cosmetic Act, which gave the Federal Food and Drug Administration extended authority to regulate and oversee pre-market evaluation and safety testing of new drugs sold in the United States. Although there have been no subsequent outbreaks of DEG poisoning in the United States, there have been at least nine other outbreaks in developing countries.

DEG is used in automotive anti-freeze products. DEG is not normally used in preparing medications. However, since DEG has a sweet taste, its presence in medication would not be easily detected by consumers.