



Student Name(s) _____

School Name and State _____

Team Number _____

**DIVISION B
DISEASE DETECTIVES**

**National Science Olympiad
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Developed by the
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Public Health Service



**Disease Detectives
National Science Olympiad
May 2007**



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**
- **Radiation (Soar, ionizing, ultraviolet, nuclear)**

Problem II. DISEASE DETECTIVES TAKE ON A BUDDING PROBLEM

Total Suggested time = 25 minutes

Legionnaires' disease is a severe respiratory infection caused by bacteria belonging to the genus *Legionella*. It was first described and the causative agent first identified in conjunction with an outbreak associated with an American Legion convention in Philadelphia, Pennsylvania in 1976. The bacteria is commonly found in lakes, streams and water supplies and infection results from exposure and inhalation of aerosols of contaminated water. The illness is commonly diagnosed by isolation or demonstration of the bacteria or bacterial antigens using indirect immunofluorescent assay (IFA) or radioimmunoassay (RIA) or by demonstrating a fourfold or greater rise in specific antibody in paired serum specimens. The following report deals with an investigation of an outbreak of Legionnaires disease associated with a flower show in the Netherlands in 1999.



The West Frisian Flower show took place on February 19 to 28, 1999 in Bovenkarspel, Netherlands and attracted 77,061 visitors. From March 7 to 11, 10 persons with severe pneumonia were admitted to a local hospital in nearby Hoorn. Six of eight persons tested had urine antigen tests positive for *Legionella*. An additional 4 probable cases were identified. Interviews with cases and a group of 21 controls indicated that 10 of 10 cases and 4 of the controls had all visited the West Frisian Flower Show.

1. (1 pt) What name is used for this type of study design?
 - **Case-control study**

2. (2 pts) Calculate the relative risk or odds ratio (whichever is most appropriate for this study design) for the association between illness and attendance at the show. Show your work in the

space below. (Since 1 cell of your table is zero, add 0.5 to each cell for your final calculation of association)

2 x 2 Table

10.5	4.5
0.5	17.5

- **Odds Ratio = $(10.5 * 17.7)/(4.5 * 5) = 81.6$**

Note:

- **1pt for correct formula**
- **1pt for correct answer**
- **No points will be awarded for calculating the relative risk**

3. Using the above information, write set of case definitions for confirmed and suspect cases (1 definition for each) that could be used for further investigations of this outbreak.

Confirmed (3 pts):

- **Person: Individuals who attended or worked at West Frisian Flower Show with pneumonia or severe respiratory illness and isolation of bacteria or demonstration of Ag by IFA or RIA or four-fold increase in antibodies**
- **Place: Bovenkarspel, Netherlands**
- **Time: February 19-28, 1999**

Suspect (3 pts):

- **Person: Individuals who attended or worked at West Frisian Flower Show with pneumonia or severe respiratory illness**
- **Place: Bovenkarspel, Netherlands**
- **Time: February 19-28, 1999**

All local hospitals and health services in the Netherlands were contacted and asked to report cases of pneumonia among persons who had attended the flower short.

4. (2 pts) List two groups of cases who are likely to be missed by the above reporting system.

Answers will vary but may include:

- **Persons who became ill outside the country**
- **Persons who became ill but did not seek medical attention**
- **Persons who became ill but either did not become ill or developed non-respiratory illness**

A number of environmental assessments were undertaken. These included generating maps of the water

system at the flower show site and interviewing exhibitors to identify all water-using products (e.g. fountains, pools, whirlpools, hot tubs, spas, etc) displayed at the exhibition site. An 8-pt risk assessment scale was used to assign a risk score to each of the latter products. Two weeks after the end of the flower show, water and swab samples were collected from all potential sources of Legionella on the site. Inquiries indicated that many of the water-using devices were not adequately maintained with respect to routine disinfection. Samples from the municipal water supply were negative for Legionella. However, the organism was cultured from paper filters from a whirlpool spa in Hall 3, a whirlpool spa in Hall 4 and a sprinkler installation in another hall (hall 8)

5. (1 pt) With respect to the timing of sample collection, what assumption is being made about the water system?
 - **The conditions of the water system at the time of the samples were collected reflect the condition during the flower show (or no changes were made to the water system between the flower show and the collection of the samples)**
6. (2 pts) How does this influence the interpretation of both positive and negative test results?
 - **If bacteria were found in the samples you are assuming the bacteria were present during the flower show**
 - **If bacteria were not found in the samples, bacteria may not have been present during the flower show or conditions changed between the flower show and the collection of samples**

Note: Both responses are needed for full credit

There were 133 confirmed and 55 probable cases were reported in visitors (178) and exhibitors (10). Dates of onset in these cases ranged from February 25 to March 16. 163 of these persons were hospitalized and 17 confirmed and 4 probable cases died.

7. (2 pts) Assuming that exposure took place during the exhibition, give the range of incubation periods for these cases. (NOTE: In 1999, February had 28 days)

Shortest Incubation Period = last date of possible exposure – first date of disease onset = February 25 – February 28 = <1 day

Longest Incubation Period = 1st date of possible exposure – last date of disease onset = February 19 - March 16 = 25 days

Incubation Range = Less than 1 day to 25 days

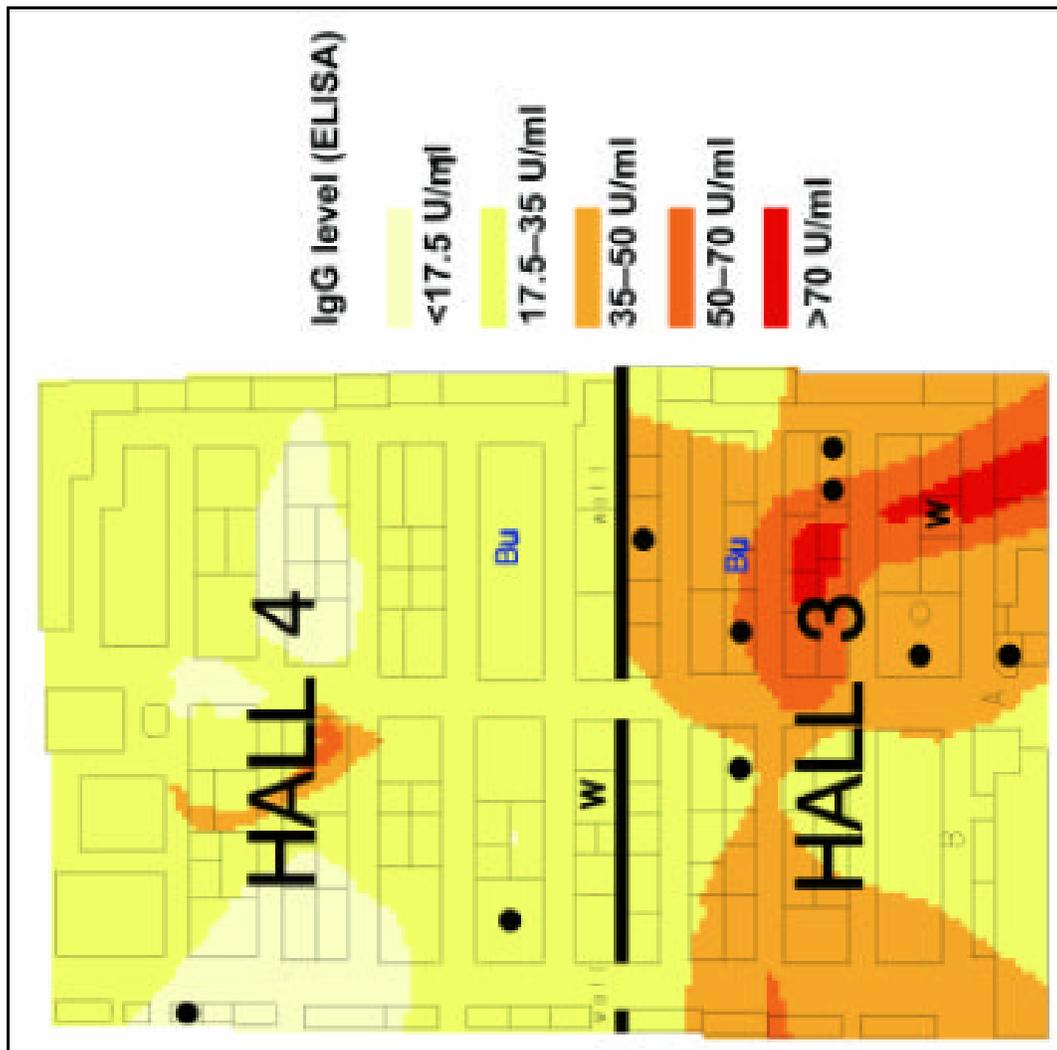
8. (2 pts) Calculate the overall case fatality rate for this outbreak. Show your work in the space below.

Case Fatality Rate: (Confirmed Case Deaths + Probable Case Deaths)/(Confirmed Cases + Probable Cases) = (17 + 4)/(133 + 55) = 21/188 = 11.1%

Investigators asked 1616 exhibition volunteers, staff of the company organizing the exhibition and

exhibitors to complete a survey regarding their health status before and after the exhibition and to have paired blood specimens collected. These were tested for IgM and IgG antibody levels. The levels of IgM and, to some extent, IgG indicate infection with or exposure to *Legionella*. The exhibition halls were divided into 63 cm² grids and the geometric mean levels of IgG and IgM determined for the 35 persons in or closest to each grid. The results are shown in Figure 1.

Figure. 1. Smoothed mean geometric immunoglobulin (Ig) M antibody titers to *Legionella pneumophila* of nearest 35 exhibitors in hall 3 and 4 per 63 cm² of exhibition area; confirmed and probable cases among exhibitors in halls 3 and 4. ● = confirmed case in exhibitor; ○ = probable case in exhibitor; Bu = bubblemat; W = whirlpool spa. (NOTE- Figure is mislabeled – it says IgG level but should be IgM.



9. (2pts) Which items appear to be linked with increased IgM to *Legionella pneumophila*?
- Whirlpool in Hall 3
 - Bubble Mat in Hall 3

10. (2 pts) Why did investigators chose exhibitors rather than visitors for this part of the investigation?

Exhibitors are more likely to remain in one place while visitors move all over – thus exhibitors exposure date was more limited than exposure data from visitors

Investigators used a municipal population register to select a random sample of 2500 men and 2500 women born before 1960. All 5000 persons were contacted and asked to participate in a survey only if they had visited the flower show. Surveys were sent to 196 men and 203 women.

The survey asked about health status and details about visits to the flower show and included a questionnaire, set of situational drawings and a floor plan of the exhibition site. Respondents were excluded if they reported symptoms of respiratory illness within 20 days of their attending the flower show. Cases were interviewed in person or by proxy.

Table 1: Comparison of host factors and visits at specific sites at the exhibition for cases and controls.

Sites Visited	Cases (n=101)	Controls (N=119)	
Paused at Hall 3 Whirlpool	41	21	
Paused at Hall 3 Bubblemat	37	17	
Paused at Hall 3 Gangway Bubblemat	24	35	

1 (6 pts) Calculate appropriate measure of risk (relative risk or odds ratio) for the listed sites visited

Hall 3 Whirlpool:

	Cases	Controls
Paused at Hall 3 Whirlpool	41	21
Did Not Pause at Hall 3 Whirlpool	60	98
Total	101	119

Odds Ratio: $(41 * 98)/(21 * 60) = 4018/1260 = 3.2$

Hall 3 Bubblemat

	Cases	Controls
Paused at Hall 3 Bubblemat	37	17
Did Not Pause at Hall 3 Bubblemat	64	102
Total	101	119

Odds Ratio: $(37 * 102)/(17 * 64) = 3774/1088 = 3.5$

Hall 3 Gangway Bubblemat

	Cases	Controls
Paused at Hall 3 Gangway Bubblemat	24	35
Did Not Pause at Hall 3 Gangway Bubblemat	77	84
Total	101	119

Odds Ratio: $(24 * 84)/(35 * 77) = 2016/2695 = 0.75$

11. (3 2pts) What do these results tell you about the risk associated with exposure to above three devices?

Persons who stopped at the whirlpool or hall 3 bubblemat were 3.2 and 3.5, times more likely to become ill than those who did not. Those who stopped in the gangway bubblemat in Hall 3 were less likely to become ill than those who did not.

**Problem III: DISEASE DETECTIVES INVESTIGATE AN OUTBREAK OF
ACCIDENTAL POISONING**

Total Suggested time = 15 minutes



Between the months of November 1995 and May 1996, approximately 32 children with unexplained kidney failure (inability to urinate) were admitted to the University General Hospital in Haiti. No children had been admitted for kidney failure in the preceding 5 years. There were no reports of similar illness in other neighboring countries. All but one of the 32 children with kidney failure died. Local health officials suspected contaminated medication was the most likely cause of this illness.

1. (3pt) Give the definition of an outbreak.

The occurrence of more cases of disease, injury, or other health condition than expected in a given area or among a specific group of persons during a specific period.

2. (2pt) Give 2 facts in the above description that tell you this was an outbreak?

Two of the following:

- **All were children**
- **All were from Haiti and not neighboring countries**
- **All had the same illness**
- **All presented during a defined time period**
- **No children admitted for kidney failure in preceding 5 years**

3. (2pts) Calculate the case fatality rate. Show your work.

Case Fatality Rate = Total Deaths/ Total ill = 31/32 = 97%

Disease detectives begin an investigation to determine the cause of this outbreak. The hospital did not have admission or discharge logbooks so cases of kidney failure could not be identified by reviewing hospital records. Instead, disease detectives identified cases by talking to doctors and asking them to remember if they had treated children for kidney failure. Also, cases were identified through disease surveillance lists collected by the Haitian Ministry of Health, notifications from private doctors, and community reports from field health workers.

4. (2pts) Identify two groups of children that these methods would not capture.

Answers may vary but can include:

- **Children whose parents did not seek medical attention**
- **Children whose parents did not have access to health care**

Disease detectives considered the following products as possible sources of exposure: syrup-based medications, skin creams, herbal remedies, bath products, and tonics. Samples were analyzed by the CDC Environmental Health laboratory. Diethylene glycol, or DEG, was detected in the syrups. Disease detectives began a study to identify which of the syrup medications was the cause of the outbreak. They talked to families of the children with renal failure, and with families of children who had been in the hospital for other types of illnesses. They asked questions asked about types of medications used, and how often they were used by the children.

5. (1 pt) What do disease detectives call this type of study?

Case-control study

Disease detectives analyzed the data from these questions and calculated an odds ratio of 52.7 for use of either of two types of pain relief medication. No other medication use had a statistically significant odds ratio. The laboratory analysis had revealed that other medications produced by the same manufacturer also were contaminated with DEG. When exposure was defined as including any of the DEG-contaminated medication the odds ratio for exposure was 44.2.

6. (1 pt) Give one explanation for why the odds ratio for any DEG-contaminated medication was lower than the odds ratio for DEG-contaminated pain medication.

Any of the following will be accepted as correct:

- **Pain medication may have had a higher concentration of DEG in it, thereby causing a greater degree of illness and a subsequent higher association**

- **Pain medication usage among children may be much higher than other medication usage, thereby creating a larger group and a stronger association**
- **Parents with children with renal failure may better recall giving pain medications than parents of children who were sick but did not have renal failure, therefore creating a stronger association due to recall bias.**

7. (1 pt) The odds ratio is one measure of association that disease detectives use. Name another measure.

Any of the following are acceptable:

- **Relative risk**
- **Risk difference**
- **Excess risk**
- **Cumulative incidence ratio**
- **Rate ratio**
- **Incident density ratio**
- **Prevalence ratio**

Disease detectives next conducted a study of 49 well children who had been given pain relief syrup from the contaminated lots. The children were monitored for a mean of 87 days from the last dose of contaminated syrup to determine possible illness from the syrup. All 49 children survived, and none developed signs or symptoms of DEG toxicity. However, some had findings on their lab tests for kidney and liver function that were evidence of sub-clinical toxic effect.

8. (1 pt) What do disease detectives call this type of study?

- **Cohort study**

9. (2 pts) What is the difference between clinical and sub-clinical effect?

Clinical effects are signs or manifestations of disease that are readily apparent to patients and/or health care workers. (visible signs or symptoms of disease)

Sub clinical effects are manifestations of disease that are not readily apparent to patients and/or health care workers and usually require specific testing to identify (no visible signs of disease, but abnormal laboratory findings).

For some children in the two studies, disease detectives could estimate the DEG dose ingested per kilogram of body weight. For children who became ill the mean dose ingested was 1.35mL/kg. For children who did not become ill the mean ingested dose was 0.84 mL/kg (p = .04).

10. (2 pt) Give one term disease detectives could use to describe this difference?

- **Statistically significant**

11. (1 pt) Based on the above, on the average, how much DEG would be ingested by an ill child who weighed 25 kg? (Show your work)

$$1.35 \text{ mL/kg} * 25 \text{ kg} = 33.75 \text{ mL DEG}$$

Disease detectives next conducted a study called a traceback investigation to determine possible sources of DEG contamination of the medication. They reviewed production records from the medication manufacturer. This identified the source as DEG contaminated glycerin syrup imported from China. Glycerin is one component of the syrup used to manufacture liquid medications in Haiti.

12. (1 pt) What immediate intervention could disease detectives use to prevent further cases of DEG poisoning in this community?

Answers will vary but may include

- **Recall all medications produced in Haiti that used this glycerin**
- **Shut down manufacturing facility**
- **Public announcement to not use the brand of pain relieving syrup**

Note: All interventions must show effects immediately upon implementation. Long-term interventions are not acceptable