



DISEASE DETECTIVES – SAMPLE TOURNAMENT

PART I: (Cohort Study)

At least 70 people attending a national conference in a city in Texas became ill with what appeared to be food poisoning. Three hospitals in the area treated and released 48 attendees who complained of nausea and vomiting; others with similar symptoms were hospitalized overnight. A health official noted that all of the patients had eaten brunch or lunch at the same hotel.

The hotel's lunch menu included roast chicken, roast beef, and a vegetable pasta dish. Because some of the people who became ill were vegetarian, there was particular interest in determining whether the pasta dish might be contaminated. At the time of the report, health officials were still looking for the source of the outbreak. The hotel was cooperating in the investigation and had voluntarily halted food service for the time being.

Questions

1. Explain why you might consider this problem important enough to investigate. Give at least three reasons for investigating.
2. Briefly describe the initial steps that you would take in investigating this problem. Indicate the type of data needed to accomplish each step and give examples of sources of such data in a community.
3. Develop and specify probable hypotheses to explain the cause, source, and spread of the outbreak.
4. Describe approaches to testing alternative hypotheses.
5. Develop suitable recommendations and interventions for controlling the problem.

PART II: (Case-Control Study)

In September 1994, the Minnesota Department of Health detected an increase of reports of *Salmonella enteritidis* infections. After an initial investigation, a nationally distributed brand of ice cream was implicated in the outbreak. Disease detectives established national surveillance and surveyed customers of the implicated manufacturer. Cultures for bacteria were obtained from ice cream samples, the ice cream plant, and tanker trailers that had transported the ice cream base (premix) to the plant.

Questions

1. Is this an outbreak? If so, what criteria of an outbreak does this incident meet?
2. A case control study was conducted to determine risk factors for factors for illness. Cases were defined as person with cultured-confirmed *S. enteritidis* infection who resided in southeastern Minnesota and who became ill during September 1994.
 - a. What parts of a case definition do the above contain?
 - b. Is the above case definition confirmed, probable, or suspected? What information in the above classifies the type of case of definition?
 - c. Brand X ice cream was eaten by 11 of 15 cases compared with 2 of 15 controls. An odds ratio of 10.0 (95% confidence interval, $P = 0.007$) was determined. Interpret the meaning of the odds ratio.
3. No other risk factors were identified. At this point in this investigation, can Brand X ice cream be said to be the source of the outbreak? Why or why not?

On October 7, 1994, the Minnesota Department of Health announced the findings of the case control study. Brand X initiated a nationwide recall of all ice cream made at its plant in Marshall, Minnesota. The first isolate of *S. enteritidis* from an unopened carton of ice cream was reported on October, 17, 1994.

4. What was the reason why disease detectives announced their findings on October 7th?

Of 11 *S. enteritidis* isolates from case patients, 9 were phage type 8, 1 was type 13a, and 1 was type 1.

Two hundred thirty-six unopened ice cream products made on 32 days during the period from July 12 through October 7, 1994 were sampled for culture: 8 were positive for *S. enteritidis*. Five of the eight isolates were phage type 8. Cultures of 29 flavorings and ingredients did not yield salmonella.

5. Why was finding *S. enteritidis* phage type 8 in the cultures of the unopened ice cream important to this investigation?

Investigation of Ice Cream Production

No cause of salmonella contamination could be found in either the ice cream plant or the suppliers of the ice cream premix.

Following production, pasteurized premix was transported to the Marshall plant in tanker trailers and eventually made into ice cream. Neither the premix nor other ingredients were pasteurized after delivery to the plant.

Tanker trailers used to transport the premix were also used to carry unpasteurized liquid eggs, oils, molasses, corn syrup, and pasteurized dairy products. After July 1st, backhauling a load of unpasteurized eggs after loading a load of ice cream premix became a common practice.

Written procedures called for the washing and sanitation of tanker trailers and the outlet valve after the delivery of liquid eggs before premix was loaded. Documentation of cleaning was absent for seven tanker trailers on seven occasions during the outbreak period. To save time, drivers could elect to bypass the cleaning procedure after unloading eggs. In addition, egg residue was discovered in one tanker trailer after cleaning. Cracks in the lining of five tanker trucks were also noted.

On October 12 through 18, the FDA obtained samples of liquid eggs from three egg-production facilities served by the trucking company. Three yielded *S. enteritidis*: one was phage type 8 and two were type 13a.

6. Based on the above information, what conclusion can be made on the cause of the contaminated premix?
7. List one change that should be made in the transportation of premix that would decrease the likelihood of a similar outbreak.

PART III: Sample Competition

Outbreaks of foodborne illness may involve either infectious or toxic agents. They may be as local as a family meal or as large as a multistate outbreak involving thousands of individuals. The one thing they all have in common is that people get sick from eating contaminated food.

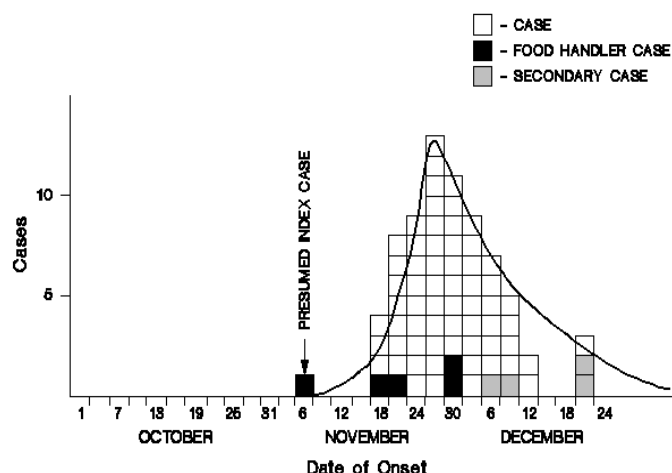
1. (1 pt) Epidemiologists divide transmission patterns into direct and _____.
2. (1 pt) The latter transmission pattern from question 1 includes airborne, _____, and vehicleborne infections.
3. (1 pt) Which of the three categories in question 2 includes foodborne illness? _____
4. (1 pt) Which of the major groups of pathogens (domain or kingdom level) does not multiply in contaminated food items?

A junior employee at a large Midwestern health department noticed an increase in the number of cases of *Salmonella typhimurium* and called this to the attention of his supervisor. *S. typhimurium* is just one of over 2,000 named serotypes of *Salmonella*. Although it is not particularly rare, several other serotypes are much more common than *S. typhimurium*.

5. (1 pt) What type of pathogen is *Salmonella typhimurium*? _____
6. (1 pt) What term do epidemiologists use for this systematic collection, analysis, and interpretation of health data on an ongoing basis? _____

7. (1 pt) What would be the next step in the investigation?

- Contact all the *S. typhimurium* cases reported over the last month and ask them what they ate in the last week.
- Make a spot map of all the *S. typhimurium* cases reported over the last month and identify restaurants within a 5 block radius of their homes.
- Contact other health departments in the area and ask if they had seen a similar increase in numbers of cases.
- Determine the number of *S. typhimurium* cases reported during the same period the previous year and compare that with the number of cases reported this year.
- Look for another job, because things are about to get rough.



8. (1 pt) What term do epidemiologists use for the above graph? _____

9. (1 pt) Based on the graph drawn for a particular outbreak, epidemiologists categorize outbreaks into certain epidemic patterns or shapes, based the number of sources, the length of the exposure, and the incubation period of the pathogen. What type of outbreak is reflected by the above graph? _____

10. (1 pt) On what date was the peak of the outbreak? _____

11. (1 pt) Given that the average incubation period of *S. typhimurium* is 48 hours, what is the most likely date of exposure for the disease outbreak? _____

12. (1 pt) According to the above graph, how many secondary cases of *S. typhimurium* were there? _____

Calls to state and other local health officials indicated that there was a statewide increase in *S. typhimurium* reports over the last two weeks. Levels of other *Salmonella* serotypes and enteric diseases were stable. All enteric disease cases (*Salmonella typhimurium* cases, non-typhimurium *Salmonella* cases, *Shigella* cases, *Giardia* cases, and hepatitis A cases), whose residence was within the jurisdiction of the health department and who were interviewed over the next three weeks, were asked to indicate which of the foods on the list they ate and where they ate the food. The disease detectives interviewed a total of 35 persons with *S. typhimurium* infections and 34 persons with non-typhimurium *Salmonella* or other enteric infections. Results from interviews of *S. typhimurium* cases were compared with those from persons with non-typhimurium *Salmonella* and other enteric infections.

13. (1 pt) What is the above study design? _____

14. (3 pts) Write a case definition for the above study.

15. (3 pts) Calculate the odds ratio for exposure to cooked roast beef. Please round to one decimal place.

	Salmonellosis	No salmonellosis
Ate beef	15	16
Did not eat beef	20	18

16. (3 pts) Calculate the odds ratio for exposure to milk. Please round to one decimal place.

	Salmonellosis	No salmonellosis
Drank milk	26	13
Did not drink milk	9	21

17. (3 pts) Calculate the odds ratio for exposure to fresh strawberries. Please round to one decimal place.

	Salmonellosis	No salmonellosis
Ate strawberries	21	17
Did not eat strawberries	14	17

The odds ratios for 3 other food items are listed below.

Chicken and dumplings	1.1
Macaroni and cheese	1.3
Fresh broccoli	1.8

18. (1 pt) Which of the six food items is most likely the source of the outbreak? _____

19. (2 pts) Interpret the odds ratio for the food item that is most likely the source of the outbreak.

20. (2 pts) After reviewing the food list data, the disease detectives began to investigate the local supermarkets and grocery stores. What information caused health officials to focus on supermarkets and grocery stores rather than restaurants or fast food chains?

21. (2 pts) Once the source of the outbreak was confirmed, list two next steps that the investigators should have initiated to control the outbreak.

DISEASE DETECTIVES – SAMPLE TOURNAMENT ANSWER KEY

PART I:

- 1. The problem appears serious because a large number of people attending the same event became ill with similar symptoms at the same time. Many of them were sick enough to need hospital care. Some of the reasons for investigating are to find out if a common infectious organism or toxic agent caused the illness, to prevent additional cases of illness from the same source, and to recommend ways of preventing the recurrence of this problem in another place or time.**
- 2. *Step 1:* Confirm the diagnosis—you should first make certain that these people actually had gastroenteritis and that this report does not represent either a mistake in diagnosis or mass hysteria. Data Needs and Sources: You need to get diagnostic data from local doctors and hospital emergency room staff.**

***Step 2:* Confirm that an outbreak really occurred—you should show that the number of people with gastroenteritis in this group was higher than would normally be expected. Data Needs and Sources: You need to know how many people attended the meeting. Unfortunately, the press report does not give this information, but the hotel or the organization sponsoring the conference would be able to help.**

***Step 3:* Define and identify cases of illness—you will first need to develop a case definition using data on the symptoms, the time and place the illness occurred, and common characteristics of the people who were ill.**

***Case Definition:* "the onset of some combination of acute gastrointestinal symptoms (e.g., nausea, vomiting, diarrhea, and cramps) in a person attending the XYZ Conference held in Someplace, Texas, on June 4-6, 1998."**

***Data Needs and Sources:* To identify cases, you need to interview either all of the people attending the conference or a representative sample of those people. You might also interview hotel employees and food servers. You should be able to get addresses and telephone numbers for conference participants by asking the organizers for a copy of the master registration list. You would also need to contact area physicians, clinics, and hospital emergency rooms.**

- 3. The news report stated that everyone who became ill had eaten brunch or lunch on Wednesday at the same hotel; that the menu included chicken, beef, and vegetable pasta; and that vegetarians were among those who became ill. Possible hypotheses are**

One or more of these food items was contaminated with a microorganism (bacteria or virus) or toxin that causes gastroenteritis. However, the newspaper account is probably incomplete, and beverages and other food items were probably served.

If any of the foods or beverages are eventually proven to be contaminated, they would be considered a "common source" for the outbreak.

It could be that none of the items served by the hotel over the lunch hour was contaminated and that people were exposed elsewhere. For example, those who became sick could have been together at a meeting someplace else where contaminated snacks and beverages were served during a break.

4. Two of the most important methods for testing hypotheses are cohort studies and case-control studies. Both use a comparison group to evaluate the relationships between different exposures and the risks of disease. The nature of the outbreak determines which of these studies is used.

Cohort studies are used for outbreaks in small, well-defined populations, for which a complete list of participants is available. In this type of study, groups of people who have been exposed to suspected risk factors are compared with groups who have not been exposed. For example, in the gastroenteritis outbreak described here, you could use a cohort study to examine the role of each food and beverage item by determining and then comparing the "relative risk" of illness for each item. The relative risk for each item is calculated by dividing the illness incidence (or "attack rate") among people who ate or drank the item by the incidence among people who did not.

Case-control studies compare people with a disease (case-patients) with a group of people without the disease (controls) and are used when the population is not well defined. In a case-control study, case-patients and controls are asked about their exposures. You compare the proportion of cases and controls exposed to each risk factor and use these proportions to calculate an "odds ratio," which is a measure of the relation between the exposure and likelihood of disease.

5. In the outbreak described above, the decision to shut down the hotel's food service may have been based on preliminary findings of the investigation. Once the investigation pinpointed the source of the contaminated food, health officials might have included one or more of the following measures in their recommendations for food handlers:
 - Wash hands, knives, and cutting boards and other work surfaces after each handling of uncooked food.
 - Wash raw produce thoroughly before serving it or placing it on work surfaces for preparation.
 - Keep prepared produce refrigerated until served.
 - Keep uncooked meats separate from vegetables, cooked foods, and ready-to-eat foods.
 - Cook raw meat thoroughly.
 - Cook leftover foods or ready-to-eat foods until they are steaming hot.
 - Do not allow food workers to work when they are experiencing a gastrointestinal illness.

PART II

In September 1994, the Minnesota Department of Health detected an increase of reports of *Salmonella enteritidis* infections. After an initial investigation, a nationally distributed brand of ice cream was implicated in the outbreak. Disease detectives established national surveillance and surveyed customers of the implicated manufacturer. Cultures for bacteria were obtained from ice cream samples, the ice cream plant, and tanker trailers that had transported the ice cream base (premix) to the plant.

Questions

8. Is this an outbreak? If so, what criteria of an outbreak does this incident meet?

Answer: Yes, more cases of *S. enteritidis* were reported than expected during September 1994.

An outbreak is the occurrence of more cases of a disease, injury, or other health condition in a given area or among a specific of persons during a specific time period.

9. A case control study was conducted to determine risk factors for factors for illness. Cases were defined as person with cultured-confirmed *S. enteritidis* infection who resided in southeastern Minnesota and who became ill during September 1994.

- a. What parts of a case definition do the above contain?

Answer: The above case definition contains details of person, place and time. It also includes clinical criteria.

A case definition is a set of uniformly applied criteria for determining whether a person should be identified as have a particular disease, injury, or other health condition. In epidemiology, particularly for an outbreak investigation, a case definition specifies clinical criteria and details of time, place, and person.

- b. Is the above case definition confirmed, probable, or suspected? What information in the above classifies the type of case of definition?

Answer: The above is a confirmed case definition because it contains laboratory confirmation (cultured-confirmed *S. enteritidis* infection)

A case classified as probable usually has typical clinical features of the disease without laboratory confirmation.

A case classified as suspect (or possible) usually has fewer of the typical clinical features

- c. Brand X ice cream was eaten by 11 of 15 cases compared with 2 of 15 controls. An odds ratio of 10.0 (95% confidence interval, $P = 0.007$) was determined. Interpret the meaning of the odds ratio.

Answer: Cases who had eaten Brand X ice cream were 10 times more likely to develop a *S. enteritidis* infection than controls that had not eaten Brand X ice cream.

Odds ratio: a measure of association used in comparative studies, particularly case-control studies that quantifies the association between an exposure and a health outcome.

10. No other risk factors were identified. At this point in this investigation, can Brand X ice cream be said to be the source of the outbreak? Why or why not?

No, the odd ratio suggests that there is a strong association but no laboratory confirmation of *S. enteritidis* from ice cream samples has been completed.

On October 7, 1994, the Minnesota Department of Health announced the findings of the case control study. Brand X initiated a nationwide recall of all ice cream made at its plant in Marshall, Minnesota. The first isolate of *S. enteritidis* from an unopened carton of ice cream was reported on October, 17, 1994.

11. What was the reason why disease detectives announced their findings on October 7th?

Answer: To avoid additional incidents of disease.

In cases like this public health officials should not require confirmation of microbial contamination of a product before taking action when sufficient epidemiologic evidence implicates that product.

Of 11 *S. enteritidis* isolates from case patients, 9 were phage type 8, 1 was type 13a, and 1 was type 1.

Two hundred thirty-six unopened ice cream products made on 32 days during the period from July 12 through October 7, 1994 were sampled for culture: 8 were positive for *S. enteritidis*. Five of the eight isolates were phage type 8. Cultures of 29 flavorings and ingredients did not yield salmonella.

12. Why was finding *S. enteritidis* phage type 8 in the cultures of the unopened ice cream important to this investigation?

Answer: This strengthens the hypothesis that Brand X ice cream was the source of this specific outbreak.

If another type of *S. enteritidis* was found the association of illness with the consumption of Brand X ice cream would decrease. Further investigation into other risk factors (exposures) would be needed.

Investigation of Ice Cream Production

No cause of salmonella contamination could be found in either the ice cream plant or the suppliers of the ice cream premix.

Following production, pasteurized premix was transported to the Marshall plant in tanker trailers and eventually made into ice cream. Neither the premix nor other ingredients were pasteurized after delivery to the plant.

Tanker trailers used to transport the premix were also used to carry unpasteurized liquid eggs, oils, molasses, corn syrup, and pasteurized dairy products. After July 1st, backhauling a load of unpasteurized eggs after loading a load of ice cream premix became a common practice.

Written procedures called for the washing and sanitation of tanker trailers and the outlet valve after the delivery of liquid eggs before premix was loaded. Documentation of cleaning was absent for seven tanker trailers on seven occasions during the outbreak period. To save time, drivers could elect to bypass the cleaning procedure after unloading eggs. In addition, egg residue was discovered in one tanker trailer after cleaning. Cracks in the lining of five tanker trucks were also noted.

On October 12 through 18, the FDA obtained samples of liquid eggs from three egg-production facilities served by the trucking company. Three yielded *S. enteritidis*: one was phage type 8 and two were type 13a.

13. Based on the above information, what conclusion can be made on the cause of the contaminated premix?

Answer: Cross contamination of pasteurized ice cream premix occurred during transport in tanker trailers that had previously hauled nonpasteurized liquid eggs containing *S. enteritidis*.

14. List one change that should be made in the transportation of premix that would decrease the likelihood of a similar outbreak.

**Answer: 1) Tanker trucks should only carry ice cream premix
2) Pre-mix should be repasteurized after transportation**

Increased enforcement of the original written procedures is not an adequate recommendation as even a “clean” tanker truck was found to have egg residue and cracks were noted in 5 other trucks.

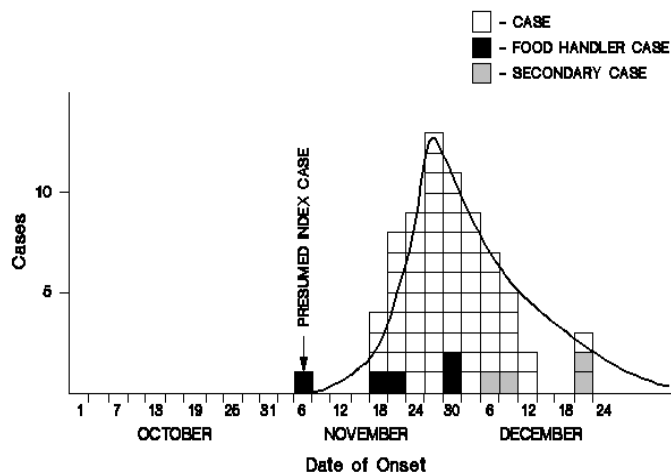
PART III: SAMPLE COMPETITION

Outbreaks of foodborne illness may involve either infectious or toxic agents. They may be as local as a family meal or as large as a multistate outbreak involving thousands of individuals. The one thing they all have in common is that people get sick from eating contaminated food.

22. (1 pt) Epidemiologists divide transmission patterns into direct and indirect.
23. (1 pt) The latter transmission pattern from question 1 includes airborne, vectorborne, and vehicleborne infections.
24. (1 pt) Which of the three categories in question 2 includes foodborne illness? vehicleborne
25. (1 pt) Which of the major groups of pathogens (domain or kingdom level) does not multiply in contaminated food items? Viruses or parasites

A junior employee at a large Midwestern health department noticed an increase in the number of cases of *Salmonella typhimurium* and called this to the attention of his supervisor. *S. typhimurium* is just one of over 2,000 named serotypes of *Salmonella*. Although it is not particularly rare, several other serotypes are much more common than *S. typhimurium*.

26. (1 pt) What type of pathogen is *Salmonella typhimurium*? bacterium
27. (1 pt) What term do epidemiologists use for this systematic collection, analysis, and interpretation of health data on an ongoing basis? surveillance
28. (1 pt) What would be the next step in the investigation?
- Contact all the *S. typhimurium* cases reported over the last month and ask them what they ate in the last week.
 - Make a spot map of all the *S. typhimurium* cases reported over the last month and identify restaurants within a 5 block radius of their homes.
 - Contact other health departments in the area and ask if they had seen a similar increase in numbers of cases.
 - Determine the number of *S. typhimurium* cases reported during the same period the previous year and compare that with the number of cases reported this year.**
 - Look for another job, because things are about to get rough.



29. (1 pt) What term do epidemiologists use for the above graph? **Epidemic curve**
30. (1 pt) Based on the graph drawn for a particular outbreak, epidemiologists categorize outbreaks into certain epidemic patterns or shapes, based the number of sources, the length of the exposure, and the incubation period of the pathogen. What type of outbreak is reflected by the above graph? **Point common source**
31. (1 pt) On what date was the peak of the outbreak? **December 27–29**
32. (1 pt) Given that the average incubation period of *S. typhimurium* is 48 hours, what is the most likely date of exposure for the disease outbreak? **December 21–23**
33. (1 pt) According to the above graph, how many secondary cases of *S. typhimurium* were there? **4**

Calls to state and other local health officials indicated that there was a statewide increase in *S. typhimurium* reports over the last two weeks. Levels of other *Salmonella* serotypes and enteric diseases were stable. All enteric disease cases (*Salmonella typhimurium* cases, non-typhimurium *Salmonella* cases, *Shigella* cases, *Giardia* cases, and hepatitis A cases), whose residence was within the jurisdiction of the health department and who were interviewed over the next three weeks, were asked to indicate which of the foods on the list they ate and where they ate the food. The disease detectives interviewed a total of 35 persons with *S. typhimurium* infections and 34 persons with non-typhimurium *Salmonella* or other enteric infections. Results from interviews of *S. typhimurium* cases were compared with those from persons with non-typhimurium *Salmonella* and other enteric infections.

34. (1 pt) What is the above study design? **case control study**
35. (3 pts) Write a case definition for the above study.

- All enteric disease cases (*Salmonella typhimurium* cases, non-typhimurium *Salmonella* cases, *Shigella* cases, *Giardia* cases, and hepatitis A cases)**
- residence was within the jurisdiction of the health department**
- interviewed over the next three weeks**

(3 pts) Calculate the odds ratio for exposure to cooked roast beef. Please round to one decimal place.

	Salmonellosis	No salmonellosis
Ate beef	15	16
Did not eat beef	20	18

$$270/320 = 0.84375 = 0.8$$

36. (3 pts) Calculate the odds ratio for exposure to milk. Please round to one decimal place.

	Salmonellosis	No salmonellosis
Drank milk	26	13
Did not drink milk	9	21

$$546/117 = 4.66666 = 4.7$$

37. (3 pts) Calculate the odds ratio for exposure to fresh strawberries. Please round to one decimal place.

	Salmonellosis	No salmonellosis
Ate strawberries	21	17
Did not eat strawberries	14	17

$$357/238 = 1.5$$

The odds ratios for 3 other food items are listed below.

Chicken and dumplings	1.1
Macaroni and cheese	1.3
Fresh broccoli	1.8

38. (1 pt) Which of the six food items is most likely the source of the outbreak? **Milk**

39. (2 pts) Interpret the odds ratio for the food item that is most likely the source of the outbreak. **People with salmonellosis were 4.4 times more likely than people without salmonellosis to have drunk milk.**

40. (2 pts) After reviewing the food list data, the disease detectives began to investigate the local supermarkets and grocery stores. What information caused health officials to focus on supermarkets and grocery stores rather than restaurants or fast food chains? **Items with higher odds ratios were fresh/not cooked; usually get milk from the grocery store/supermarket**

41. (2 pts) Once the source of the outbreak was confirmed, list two next steps that the investigators should have initiated to control the outbreak. **Tell the media, take the milk off the shelves**