

**Disease Detectives Investigate Outbreaks
of *Salmonella enteritidis***

As population growth continues demand for food production will also increase. Avenues for contamination in the growing, distribution, and transportation of food will also increase. For example, the closeness of livestock (poultry, cattle, and swine) to water sources and other agricultural products (vegetables) can create an environment in which contamination is likely. Products may originate in a single location but then be shipped regionally, nationally, or perhaps internationally, leading to outbreaks over a large geographic area. *Disease detectives* (or epidemiologists) are public health professionals who study the distribution (frequency or where and how often it occurs) and causes of sickness or disease in specified populations. This knowledge is used to control and prevent disease. The following event describes two public health investigations of *Salmonella enteritidis*.

Problem I

The following material was adapted from the New England Journal of Medicine article, A National Outbreak of Salmonella enteritidis infections from ice cream. NJEM. 1996 May 16;334(20):1281-6

One of the first tasks disease detectives must do at the beginning of investigation is to establish the existence of an outbreak.

In September 1994, the Minnesota Department of Health detected an increase of reports of *Salmonella enteritidis* infections than expected. 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.

____ 1. (4 pts) Disease detectives determined that the first element of an outbreak (more cases of disease than expected) was met in the above scenario. List the other two criteria that this incident must meet to be considered an outbreak.

a. _____

b. _____

Disease Detectives Investigate Outbreaks of *Salmonella enteritidis*

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Problem I

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In September 1994, the Minnesota Department of Health detected an increase of reports of *Salmonella enteritidis* infections than expected. 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.

____ 1. (4 pts) Disease detectives determined that the first element of an outbreak (more cases of disease than expected) was met in the above scenario. List the other two criteria that this incident must meet to be considered an outbreak.

- a. **(2pts) given area (location) (Minnesota)**
- b. **(2pts) Specific time period (September 1994)**

Alternate Answer: Specific group of persons

____ 2. (5pts) Disease detectives conducted a small case-control study of 30 individuals (15 cases with 15 matched controls). Brand X ice cream was eaten by 11 of 15 cases compared with 2 of 15 controls. An odds ratio of 10.0 was determined.

Fill in the blanks below in the interpretation of the odds ratio.

Cases that had eaten Brand X ice cream were (A) times (B) more/less likely to develop a *S. enteritidis* infection than controls that (C) had/had not eaten Brand X ice cream.

a. _____

b. _____

c. _____

____ 3. (1pt) No other risk factors were identified. At this point in this investigation, can Brand X ice cream be identified as the source of the outbreak? Yes or No.

____ 4. (4pts) Why or why not? Circle all answers that apply.

- a. The odds ratio only indicates an association between eating ice cream and illness.
- b. The odds ratio indicates that eating ice cream was the source of illness.
- c. Fifteen people in the study are enough to determine ice cream as the source of the outbreak.
- d. Salmonella had not been found in the ice cream at this point in the investigation.

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.

____ 5. (3pts) Why did disease detectives announce their findings on October 7 prior to finding of *S. enteritidis* in the ice cream?

___ 2. (5pts) Disease detectives conducted a small case-control study of 30 individuals (15 cases with 15 matched controls). Brand X ice cream was eaten by 11 of 15 cases compared with 2 of 15 controls. An odds ratio of 10.0 was determined. Fill in the blanks below in the interpretation of the odds ratio.

Cases that had eaten Brand X ice cream were (A) times (B) more/less likely to develop a *S. enteritidis* infection than controls that (C) had/had not eaten Brand X ice cream.

- a. **10 (1pt)**
- b. **More (2pts)**
- c. **Had not (2pts)**

___ 3. (1pt) 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? Yes or No.

Answer: No

___ 4. (4pts) Why or why not? Circle all answers that apply.

- a. **The odds ratio only indicates an association between eating ice cream and illness.**
- b. The odds ratio indicates that eating ice cream was the source of illness.
- c. Fifteen people in the study are enough to determine ice cream as the source of the outbreak.
- d. **Salmonella had not been found in the ice cream at this point in the investigation.**

2pts for each correct answer

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.

___ 5. (3pts) What was the reason why disease detectives announced their findings on October 7 prior to the finding of *S. enteritidis* in the ice cream?

Answer: To avoid additional incidents of disease or prevent more people from being infected.

____ 6. (3pts) An initial case control-study was conducted to determine risk factors for illness. A case was defined as a person with culture-confirmed *S. enteritidis* infection who resided in southeastern Minnesota and who became ill during September 1994.

a. (1pt) Is the above case definition confirmed, probable, or suspected?

b. (2pts) What information in the above classifies the type of case of definition?

In a separate investigation, disease detectives sought to identify outbreak-associated salmonellosis in Minnesota in September and October 1994. A total of 150 confirmed cases were found.

Clinical Criteria

Confirmed Case:	Culture-confirmed <i>S. enteritidis</i> infection within one week after consumption of Brand X ice cream
Probable Case:	Occurrence of diarrhea, plus fever and chills, within one week after product consumption
Possible Case:	Two of the following symptoms: diarrhea, fever, chills, within one week after product consumption
Not a Case:	Failure to fulfill the criteria of a confirmed, probable, or possible case
Time:	Onset from September 1–October 31, 1994
Place:	Minnesota
Person:	Any

____ 6. (3pts) An initial case control study was conducted to determine risk factors for illness. Cases were defined as person with culture-confirmed *S. enteritidis* infection who resided in southeastern Minnesota and who became ill during September 1994.

- a. (1pt) Is the above case definition confirmed, probable, or suspected?

Answer: Confirmed

- b. (2pts) What information in the above classifies the type of case of definition?

Answer: Laboratory confirmation (Culture confirmed *S. enteritidis* infection)

In a separate investigation, disease detectives sought to identify outbreak-associated salmonellosis in Minnesota in September and October 1994. A total of 150 confirmed cases were found.

Clinical Criteria

Confirmed Case:	Culture-confirmed <i>S. enteritidis</i> infection within one week after consumption of Brand X ice cream
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Time:	Onset from September 1 – October 31, 1994
Place:	Minnesota
Person:	Any

ID	Initials	Diarrhea	Fever	Chills	Symptoms within one week of Consumption	Date of Onset	Laboratory Confirmation of <i>S. enteritidis</i>
1	RK	Yes	No	Yes	Yes	Sept 7	Yes
2	AE	Yes	Yes	Yes	No	Oct. 15	Not done
3	ML	Yes	Yes	Yes	Yes	Oct. 21	Pending
4	VY	Yes	Yes	No	Yes	Sept. 18	Pending
5	PO	No	Yes	Yes	Yes	Sept. 9	Not done
6	TC	No	Yes	Yes	Yes	August 21	Yes
7	SB	Yes	No	Yes	Yes	Oct. 1	Not done
8	RA	Yes	Yes	Yes	Yes	Sept. 18	Yes

____ 7. (8pts) Using the above information, assign the appropriate case definition classification (confirmed, probable, possible, or not a case) to the individuals in Table 1.

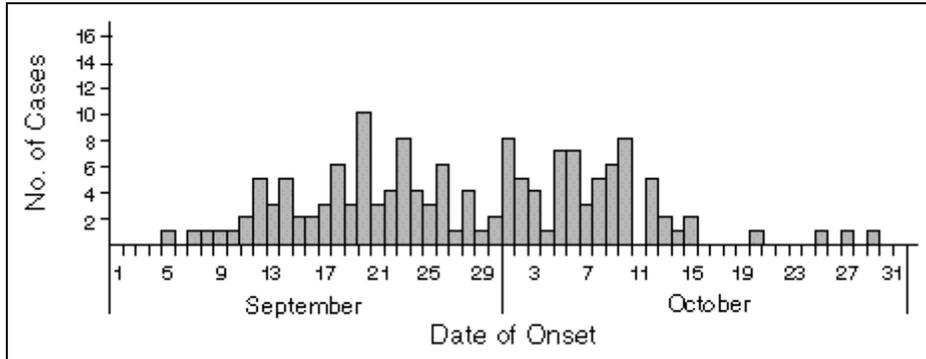
- a. RK _____
- b. AE _____
- c. ML _____
- d. VY _____
- e. PO _____
- f. TC _____
- g. SB _____
- h. RA _____

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5	PO	No	Yes	Yes	Yes	Sept. 9	Not done
6	TC	No	Yes	Yes	Yes	August 21	Yes
7	SB	Yes	No	Yes	Yes	Oct. 1	Not done
8	RA	Yes	Yes	Yes	Yes	Sept. 18	Yes

____ 7. (8pts) Using the above information, assign the appropriate case definition classification (confirmed, probable, possible, not a case) to the individuals in Table 1.

- a. RK **confirmed**
- b. AE **not a case**
- c. ML **probable**
- d. VY **possible**
- e. PO **possible**
- f. TC **not a case**
- g. SB **possible**
- h. RA **confirmed**

Figure 1. Outbreak-Associated Confirmed Cases of *S. enteritidis* Infection in Minnesota in September and October 1994, according to the date of onset



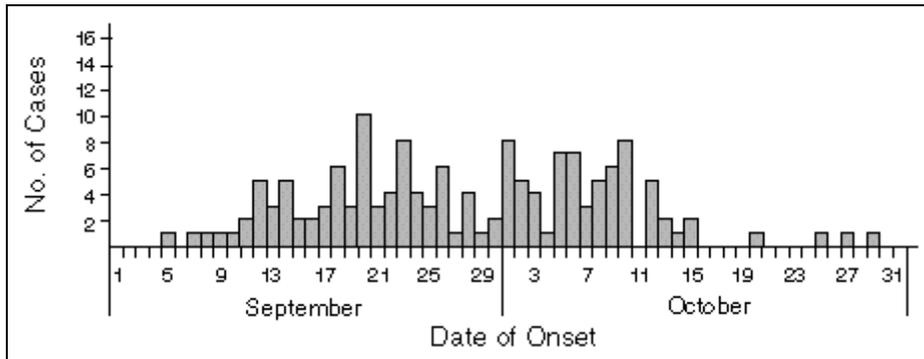
___ 8. (1pt) What name do disease detectives call the above graph?

___ 9. (1pt) The peak of this outbreak is on what day?

___ 10. (4pts) Which of the following things can a graph like the one above help a disease detective do? Circle all that apply.

- a. Identify clues about the pattern of disease spread
- b. Identify outliers
- c. Deduce a probable time of exposure
- d. Both a and b

Figure 1. Outbreak-Associated Confirmed Cases of *S. enteritidis* Infection in Minnesota in September and October 1994, according to the date of onset.



___ 8. (1pt) What name do disease detectives call the above graph?

Answer: epidemic curve or epi curve

___ 9. (1pt) The peak of this outbreak is on what day?

Answer: September 20, 1994

0.5 pt = September 20

1pt = September 20, 1994

___ 10. (4pts) Which of the following information can a graph of the above type possibly tell a disease detective? Circle all that apply.

- a. **Provide clues about the pattern of disease spread**
- b. **Identify outliers**
- c. **Deduce a probable time of exposure**
- d. **Both a and b**

Answer: 1pt for each answer

Between September 1 and September 30, 1994, Brand X shipped 138,000 gallons of ice cream in Minnesota. Thirty (30) of 452 persons who had eaten Brand X ice cream reported having diarrhea and fever or chills. None (0) of 89 persons who had not eaten Brand X ice cream reported having diarrhea and fever or chills.

____ 11. (4pts) Calculate the percentage of persons that became ill (attack rate). Round your final answer to **1** decimal place.

138,000 gallons of Brand X ice cream was distributed in Minnesota from September 1 to September 30. Disease detectives determined that on average 3.2 persons consumed each gallon of ice cream.

____ 12. (2pts) How many Minnesota residents consumed Brand X ice cream? Show your calculations.

____ 13. (3pts) Using the attack rate in #11, how many Minnesota residents do you estimate became ill after eating Brand X ice cream shipped between September 1 and September 30? Show your calculations.

____ 14. (4 pts) Approximately 87% of the ice cream produced by Brand X during the outbreak was distributed outside Minnesota. How many persons do you estimate developed illness nationwide? Show your calculations.

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____ 11. (4pts) Calculate the percentage of persons that became ill (attack rate). Round your final answer to 1 decimal place.

Answer: Attack Rate = $30 \div 452 = 0.066$ or 6.6%

4pts = $30 \div 452 = 0.066$ or 6.6%

3pts = Correct answer only

Incorrect Rounding = -0.5 pts

Must show work for full credit

138,000 gallons of Brand X ice cream was distributed in Minnesota from September 1 to September 30. Disease detectives determined that on average 3.2 persons consumed each gallon of ice cream.

____ 12. (2pts) How many Minnesota residents consumed Brand X ice cream? Show your work.

Answer: $138,000 \text{ gallons} \times 3.2 \text{ persons/gallon} = 441,600 \text{ persons}$

2pts = $138,000 \text{ gallons} \times 3.2 \text{ persons/gallon} = 441,600 \text{ persons}$

1pt= Correct Answer only

____ 13. (3pts) Using the attack rate in #11, how many Minnesota residents can be estimated became ill after eating Brand X ice cream shipped between September 1 and September 30? Show your calculations.

Answer: $138,000 \text{ gallons} \times 3.2 \text{ consumers per gallon} \times .066 \text{ (attack rate)} = 29,146 \text{ persons}$ OR $44,160 \text{ person} \times 0.066 \text{ (attack rate)} = 29,146 \text{ persons}$

3pts = $138,000 \text{ gallons} \times 3.2 \text{ consumers per gallon} \times .066 \text{ (attack rate)} = 29,146 \text{ persons}$

2pts = Correct Answer only

1pt = Correct formula with exception of correct attack rate

____ 14. (4 pts) Approximately 87% of the ice cream produced by Brand X during the outbreak was distributed outside Minnesota. How many persons can be estimated developed illness nationwide? Show your calculations.

Answer: 4pts = $(138,000 \text{ gallons} \div 13\%) \times 3.2 \text{ consumers per gallon} \times 0.066 \text{ (attack rate)} = 224,197 \text{ persons}$ OR $29,146 \text{ persons} \div 13\% = 224,200$

2pts = Correct Answer only 1pt = Correct formula with exception of correct attack rate

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 1, backhauling a load of unpasteurized eggs after loading a load of ice cream premix became a common practice.

Written procedures called for washing and sanitizing tanker trailers and the outlet valve after the delivery of liquid eggs and before the loading of premix. 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. Additionally, egg residue was discovered in one tanker trailer after cleaning. Investigators also noted cracks in the lining of five tanker trucks.

On October 12 through 18, the U.S. Food and Drug Administration (FDA) obtained samples of liquid eggs from three egg-production facilities served by the trucking company. Three yielded *S. enteritidis*.

____ 15. (2pts) Circle the term below that best describes the most likely method of *S. enteritidis* transmission to Brand X ice cream?

- a. Sabotage
- b. Cross-contamination
- c. Incubation period
- d. Mode of infection
- e. Bio-terrorism

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Problem II

The following material was adapted from the BioMed Central article, Protracted outbreak of S. enteritidis PT 21c in a large Hamburg nursing home. BMC Public Health 2007, 7:243.

In August 2006, an outbreak of *S. enteritidis* occurred in a Hamburg, Germany senior citizens home. A team of disease detectives immediately thought that transmission of disease was food-related. Initially, investigators attempted to interview residents about what they had eaten during the past two weeks. Gathering information in this way was not entirely successful, so they determined what residents had eaten by reviewing the kitchen's computerized patient-ordering system and hand-written note cards containing breakfast and dinner sandwich orders.

____ 1. (3pts) If disease detectives suspect the source of an outbreak is food, they usually interview people about the food they have eaten within a specific time period before onset of sickness. Give two reasons why this method was not as reliable in this investigation.

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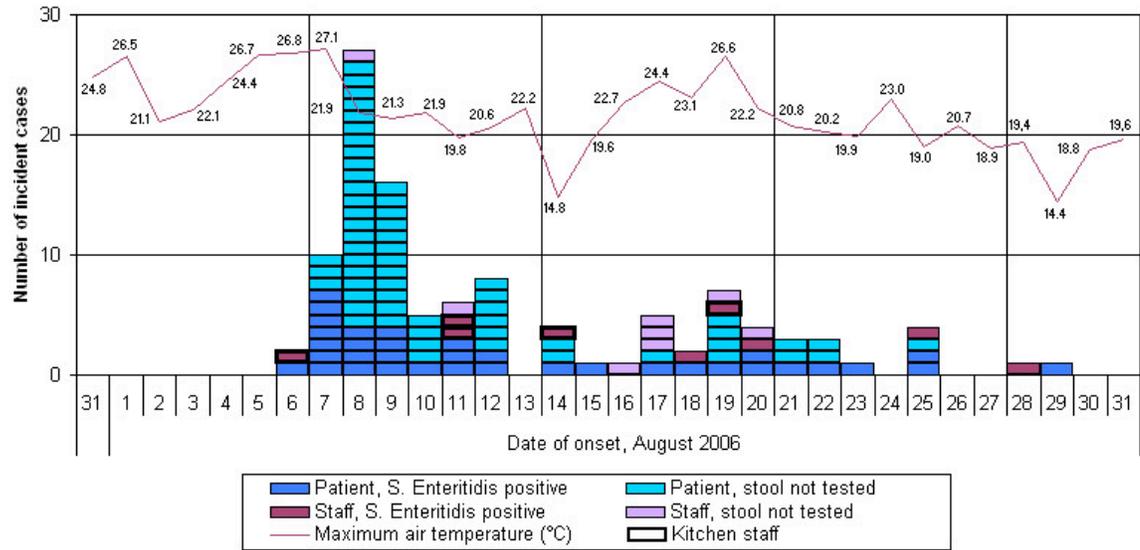
Answers can be any variation of the following:

1.5 pts per answer

Less like to recall due to:

- **Age**
- **In general it is difficult to remember what you have eaten (especially if questioning takes place significantly after)**
- **Illness**

Figure I. Outbreak-Associated Confirmed Cases of *S. enteritidis* Infection in August 2006 according to date of onset

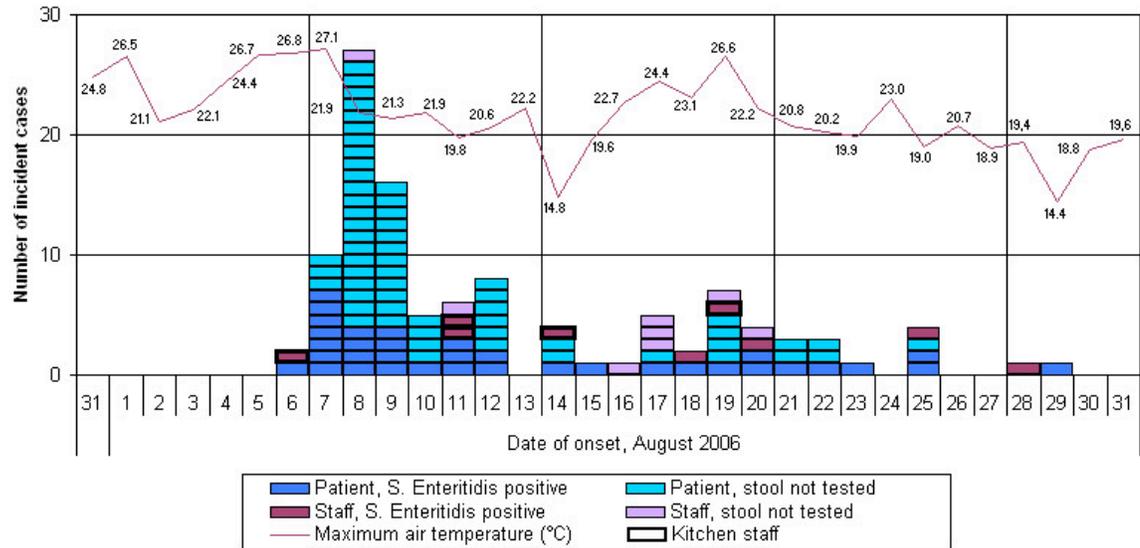


2. (3pts) This graph
- Displays the scope of an outbreak
 - Shows the number of people affected by an outbreak
 - Shows the course of the outbreak over time
 - A and B
 - All of the above
3. (2pts) When was the peak of the outbreak?

4. (1pt) How many members of the staff became ill?

5. (2pts) What percentage of ill patients were *S. enteritidis* positive? Show your work. Round your final answer to 1 decimal place.

Figure I. Outbreak-Associated Confirmed Cases of *S. enteritidis* Infection in August 2006 according to date of onset



2. (3pts) This graph
- displays the scope of an outbreak
 - shows the number of people affected by an outbreak
 - shows the course of the outbreak over time
 - A and B

e. **All of the above**

Answer: 3 pts for correct answer

2 pts for d

1 pt for a, b or c

3. (2pts) When was the peak of the outbreak?

Answer: August 8, 2006

2pt = August 8, 2006

1pt = August 8

4. (1pt) How many members of the staff became ill?

Answer: 17

5. (2pts) What percentage of ill patients were *S. enteritidis* positive? Show your work. Round your final answer to 1 decimal place.

Answer: (35 *S. enteritidis* positive/94 patients ill total) * 100 = 37.2%

2pts = 35/94 * 100

1pt = Correct answer only

Incorrect Rounding = -0.5 pts

Must show work for full credit

Table I: Case numbers and attack rates (AR) per nursing unit

Unit	No. Inhabitants	No. affected overall	AR overall (%)
1	116	20	<u>_(A)_</u>
2	118	18	15.3
3	<u>_(B)_</u>	11	9.7
4	79	11	<u>_(C)_</u>
5	97	6	6.2
6	56	13	<u>_(D)_</u>
7	41	5	12.2
8 (dementia pts)	136	0	0.0
9	65	<u>_(E)_</u>	21.5
Kitchens			
Others			
Totals	821	<u>_(F)_</u>	11.9

Frank et al. BMC Public Health 2007 7:243 doi:10.1186/1471-2458-7-243

_____ 6. (12pts) Fill in the blanks in the above table. Show your work.

a. Unit 1 =

b. Unit 3 =

c. Unit 4 =

d. Unit 6 =

e. Unit 9 =

f. Totals =

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3	_(B)_	11	9.7
4	79	11	_(C)_
5	97	6	6.2
6	56	13	_(D)_
7	41	5	12.2
8 (dementia pts)	136	0	0.0
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Kitchens			
Others			
Totals	821	_(F)_	11.9

Frank *et al.* *BMC Public Health* 2007 7:243 doi:10.1186/1471-2458-7-243

____ 6. (12pts) Fill in the blanks in the above table. Show your work.

a. Unit 1 = $(20 \div 116) * 100 = 17.2\%$

b. Unit 3 = $11 \div 0.097 = 113$

c. Unit 4 = $11 \div 79 * 100 = 13.9\%$

d. Unit 6 = $(13 \div 56) * 100 = 23.2\%$

e. Unit 9 = $.215 * 65 = 14$

f. Totals = $.119 * 821 = 98$ or $(18+11+11+6+13+5+14) = 98$

2pts each (1pt for work; 1 pt for answer)

1pt for correct answer only

____ 7. (9pts) Rank the nine units by attack rate in ascending order (smallest = 1/largest = 9) below.

Ranking	Unit Number	Ranking	Unit Number
1	Unit ____	6	Unit ____
2	Unit ____	7	Unit ____
3	Unit ____	8	Unit ____
4	Unit ____	9	Unit ____
5	Unit ____		

Disease detectives conducted a cohort study and determined that cake served with the patients' lunch was associated with illness. Investigators then decided to take a closer look at the food-delivery practices of the kitchen and the local bakery that provided the cakes. *Disease detectives* found small levels of *S. enteritidis* in two cake types at the bakery.

Bacteria are often present on food and can multiply, especially when not refrigerated and left at room temperature. Food is an environment where bacteria, if present, can multiply, especially when kept at room temperature. Nurses delivered meals to each room and were asked to place the cake in each resident's personal refrigerator, except in Unit 8, where patients needed the assistance of staff to eat the cake. No cases of disease were found in Unit 8 residents. Patients in all the other units could take the cake out of the refrigerator and eat it whenever they wished. A handwritten note reminding staff to place the cake in the refrigerator was also placed in the kitchen.

____ 8. (4pts) Although Unit 8 residents were given the same cake as all other patients, no one became ill. Give one likely reason for this.

____ 7. (9pts) Rank the nine units by attack rate in ascending order (smallest = 1/largest = 9) below.

Answer:

Ranking	Unit Number
1	Unit
2	Unit
3	Unit
4	Unit
5	Unit
6	Unit
7	Unit
8	Unit
9	Unit

1 pt for answer in correct position

Ranking	Unit Number
1	Unit 8
2	Unit 5
3	Unit 3
4	Unit 7
5	Unit 4
6	Unit 2
7	Unit 1
8	Unit 9
9	Unit 6

each the

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____ 8. (4pts) Although Unit 8 residents were given the same cake as all other patients, no one became ill. Give one likely reason for this.

Answer: Cake reserved for Unit 8 residents was kept refrigerated. However, staff delivered cake to the other residents and may have forgotten to place the cake in the refrigerator (leaving the cake out would allow the already present bacteria to multiply).

1pt = Unit 8 cakes were kept refrigerated

1pt = Staff may have forgotten to refrigerate cakes of other residents

2pts = Bacteria already present would multiply if cake was left out

OR

Answer: Cake reserved for Unit 8 residents was kept refrigerated. Staff may have refrigerated the cake, but the resident may have taken the cake out of the fridge and let it sit for several hours before eating it.

1pt = Unit 8 cakes were kept refrigerated

1pt = Staff refrigerated cake, but resident removed and allowed cake to sit

2pts = Bacteria already present would multiply if cake was left out