SCIENCE OLYMPIAD

Exploring the World of Science

Disease Detectives

The starred questions can be used as tie breakers

Total Points: 212

Part 1: Lyme Disease

Lyme disease is a multisystem illness caused by Borrelia burgdorferi, a spirochete transmitted by certain species of Ixodes ticks. Approximately 30,000 confirmed and probable cases of Lyme disease were reported in the United States in 2012, primarily from high-incidence states in the Northeast (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont) and upper Midwest (Minnesota and Wisconsin) (1,2).† Common manifestations include cutaneous, neurologic, and rheumatologic signs and symptoms.

Symptomatic infection of the heart is rare in recognized Lyme disease cases and usually resolves promptly with appropriate antibiotic therapy. Nonetheless, cardiac involvement occasionally can cause life-threatening cardiac conduction abnormalities. During November 2012–July 2013, 10 women and fifteen men (ranging in age from 26 to 38 years) from high-incidence Lyme disease states experienced sudden cardiac death and, on postmortem examination, were found to have evidence of Lyme carditis. 10 of the men and 3 of the women were not wearing any anti mosquito repellant. 5 of the men and 7 of the women were outside for less than 10 hours in tick season. The deaths were investigated by the Connecticut Department of Public Health, Massachusetts Department of Public Health, New Hampshire Department of Public Health, New York State Department of Health, and CDC. As a disease detective, you are trying to figure out the cause of these sudden deaths and this rare form of Lyme disease.

Adapted for this exercise from cdc.gov

1. (3 points) Name the 3 things epidemiologists use to characterize an outbreak.

2. (2 points) Why were the people infected not elderly or children, who are usually more susceptible to disease?

*3. (6 points) Name the three common types of studies you could use to analyze THIS TYPE OF OUTBREAK. (HINT: Pay attention to the relationship between time and disease status for this outbreak)

4. (3 points) What is the difference between a prospective and a retrospective study?

5. (3 points) What are three advantages of a cohort study?

6. (3 points) What are three disadvantages of a case control study?

7. (3 points) What are the three components of the Epidemiological Triad?

8. (1 point) Name one of the rates that any of the above study types use

You decide to conduct a study in which you match a group of people to the infected people and see if there is any specific exposure that may be the cause of this disease.

9. (3 points) What type of study design are you using?

10. (5 points) Name 3 ways you can reduce bias in this study design.

You recruit 10 women and 15 men who were not diseased to use as a comparison group.

11. (1 point). What is this group called?

12. (5 points) 4 of the healthy women and 3 of the healthy men were not wearing any anti mosquito repellent; draw a 2x2 table for this exposure.

	Case	**Control**
Exposed	13	7
Unexposed	12	18

*13. (4 points) Calculate the relative risk for this exposure. (Please show your work)

*14. (4 points) Calculate the odds ratio for this exposure. (Please show your work)

15. (4 points) Is there an increased association between exposure and sickness? Explain why using the above calculation(s).

15b. (3 points) In an outbreak or an epidemic, evidence is accumulated linking disease to a causative organism or substance. What is the name of the criteria used to prove that an organism causes a disease?

16. (5 points) List 4 types of data collected and used by epidemiologists

17. (5 points) 10 of the healthy women and 5 of the healthy men were outside for less than 10 hours during tick season; draw a 2x2 table for this exposure.

*18. (4 points) Calculate the relative risk for this exposure. (Please show your work)

*19. (4 points) Calculate the odds ratio for this exposure. (Please show your work)

*20. (7 points) Please explain how to calculate the McNemar test for paired data and what this test is.

21. (6 points) For this exposure, please calculate the log odds ratio and show your work.

22. (8 points) For this exposure, please calculate the bias corrected log odds ratio and show your work.

23. (4 points) Is there an increased association between exposure and sickness? Explain why using the above calculation(s).

24. (3 points) After you have evaluated your hypotheses, what steps should you carry out in order to further characterize this outbreak?

Part 2: Severe Stomach Illness

Hotel Sketc had its annual dinner party and served delicious food. After the party, many attendants reported feeling sick with diarrhea, vomiting, and gastrointestinal irritation. As disease detectives, you decide to investigate this outbreak of sudden illness.

	Cases				Controls			
Food	**Ate**	**Did Not Eat**	**Total**	**%Ate**	**Ate**	**Did Not Eat**	**Total**	**%Ate**
Baked Ham	29	17	46		17	12		58.62
Spinach	26	20	46		17		29	58.62
Mashed potatoes	23		46	50.00			29	48.28
Jell-O			46	34.78			29	24.14
Rolls		25	46	45.65			29	55.17
Cake	27	19	46				29	44.83
Ice cream			46	93.48	11	18	29	
Milk	2		46	4.35	2	27	29	
Water			46	28.26	11	18	29	

25. (8 points) Fill in the missing parts of the table.

26. (2 points) Which food has the highest risk of illness associated with it?

27. (2 points) Which food had the lowest risk of illness in the case group associated with it?

28. (3 points) Calculate the odds ratio of the food with the highest risk. Show your work.

29. (3 points) If all of the people who were controls happened to be, by chance, immune to stomach illness, what would this be called?

30. (2 points) If the person who interviewed the cases encouraged the cases to report additional food consumed, what would this be called?

31. (3 points) If the disease caused the memory of the cases to be hazy which led the cases to incorrectly characterize their exposure status, what would this be called?

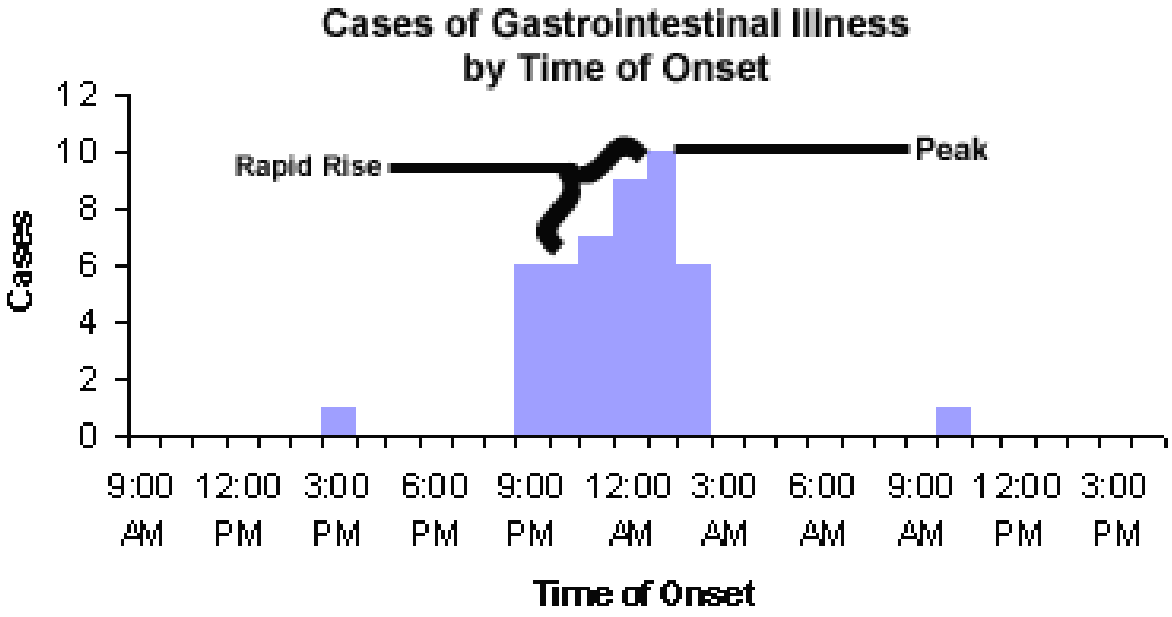
32. (2 points) Based on these results, what would you consider the cause of the outbreak?

33. (4 points) List Koch's Postulates

34. (2 points) If the food that caused the outbreak contained *E. coli* and the other food did not, would this satisfy Koch's Postulates?

35. (2 points) If the *E. coli* from the food was cultured an placed into a healthy organism but did not cause disease, would this satisfy Koch's Postulates?

You created an Epi Curve of a subset of your cases.



36. (2 points) What is the time of onset of the first case?

37. (2 points) What type of epi curve is this and why?

38. (1 point) What is the peak number of cases?

39. (2 points) Using the epi curve, estimate the incubation period.

Part 3: Happy Farms Drug Company

You're a member of the Happy Farms Drug Company testing team and you need to see how effective recent tests have been in curing Advanced Dermatitis. You conduct an experimental study.
Your test was administered to 100 people and these 100 people were enrolled in a study to test your drug, but only 50 people in the end provided you with data.

40. (3 points) What is the gold standard for clinical trial tests?

41. (3 points) What are the people called who did not give your data?

Out of the 50 people that gave you data, 15 people were diagnosed with the disease and correctly identified by the test as having the disease. 25 people overall had the disease.
10 people without the disease were marked by your test as having the test.

42. (5 points) Construct a 2x2 table with these numbers.

43. (1 point) What are the people that do not have the disease but marked positive by the test called?

44. (1 point) What are the people that do have the disease but were not marked positive by the test called?

45. (1 point) What are the people that do have the disease and were correctly marked positive by the test called?

46. (1 point) What are the people that do not have the disease and were marked negative by the test called?

47. (2 points) Please label your 2x2 table with the terms from 28-31

48. (3 points) Calculate the positive predictive value; show work and explain what this number means.

49. (3 points) Calculate the negative predictive value; show work and explain what this number means.

50. (6 points) Calculate the sensitivity and specificity; show work and explain what these numbers mean.

51. (6 points) Is this test a good indicator of the disease? Why or why not? Explain using your numbers from above.

52. (3 points) If a disease has a low cost of treatment but is very harmful to health, would you rather have a lot of false negatives or false positives? Why?

Part 4: General Epidemiology Knowledge and Advanced Statistics

For 53-58, use the following information.
A suspected outbreak of *E. coli* occurred at the Right State University campus. On September 1st, 15 people were sick. On each of the following days, 3 more people got sick until September 5th.

53. (2 points) Calculate the average number of people who got sick per day. Show your work.

54. (2 points) Calculate the variance. Show your work, the formula, and label your variables.

55. (4 points) Calculate the standard deviation. Show your work, the formula, and label your variables.

56. (2 points) Calculate the standard deviation of the mean. Show your work, the formula, and label your variables.

57. (3 points) Write the Z scores for the 90%, 95%, and 99% Confidence Interval

58. (5 points) Calculate the 90% confidence interval of the mean. Show your work, the formula, and label your variables.

59-73: Match the following vocabulary words to the definitions. (1 point each)

59. Agent	A. a widespread outbreak of an infectious disease in a specified community
60. Bacteria	B. system of doctors and health officials collecting and comparing data on various diseases or infections within communities
61. Epidemic	C. ultramicroscopic infectious agent that replicates itself only within cells of living hosts
62. Outbreak	D. an organism that transmits a pathogen
63. Virus	E. a disease causing agent
64. Symptom	F. invasion of the body by pathogenic agents
65. Public Health Surveillance	G. a substance that causes an effect
66. Exposure	H. an inanimate object that can be used in the transmission of diseases
67. Infection	I. time of the appearance of the first symptoms of an illness
68. Pathogen	J. any disease of animals communicable to humans
69. Pandemic	K. microscopic, single-celled organisms that lack chlorophyll and nuclei
70. Onset	L. a sudden occurrence of disease in two or more people during a specified period of time
71. Vector	M. a disease that occurs over a wide geographic area and affecting an exceptionally high proportion of people
72. Zoonosis	N. to come in contact with an infectious agent in a manner that promotes transmission and the likelihood of disease
73. Fomite	O. evidence or sign of disease or infection

74. (2 points) Who is the father of modern epidemiology?