Plagues: Writing Assignment 3 Epidemiology

This is not so much a writing exercise as a puzzle. It is the type of puzzle that epidemiologists do to discover the source of an infection, or patient 0. Pathogens can be transmitted through the air, on inanimate objects, in water or food, by insects or by direct contact between people.

In our epidemiology problem, over three or four days, 11 people get sick enough to go to a local hospital with severe diarrhea and vomiting that lasts four days or so in each patient. The disease is serious enough and unique enough that an intern at the hospital becomes curious about the small disease cluster, and she tests the patients for norovirus and bacterial food contaminants, including *Salmonella, E. coli* o157:H7 and *Campylobacter*. All the patients turn out to all have the same strain of norovirus.

The intern asked a few questions to see what the patients had in common, and it turned out that they all knew each other and over the summer had been sharing produce from their gardens. The intern asked what, specifically, they had shared for fresh, uncooked produce over the last week, who they had shared with, and when. Her hypothesis was that one person had norovirus, and had transmitted the virus to others on the food. She made a list, numbered the patients, starting with the patient that had first shared, and who they had shared with. It turned out a total of 16 people had shared produce, so she contacted the additional people who had not gotten sick, and asked them who they had shared produce with and when. In the end, she came up with the list below. So, patient 1 first shared vegetables with patient 12, then with patient 14. Patient 2 first shared vegetables with patient 5, then with patient 15, and so on. And patient 1 never got ill, while patient 2 did. Any time that two people come in contact with each other, the virus can move either way. For example it would be possible for patient 2 to have infected patient 5, or patient 5 to infect patient 2.

After studying the list, she said, “I know who started this!” She asked that patient where they had been recently and it turned out they’d been on a cruise ship that had had a severe outbreak of norovirus! Based on her data, which patient was the one who went on the cruise and started the epidemic?

*The best way to work through this assignment may be to read “**The Basic Approach**” (page 2) which refers to “**The Data**” (page 3) to get an idea of how the data is organized. Then look at the “**Example of a similar problem**” on page 4 on how exactly to answer the questions in “**The Assignment**” section of page 3.

The Basic Approach:

The first rule as stated in "The Hitchhiker's Guide to the Galaxy" is DON'T PANIC. Instead, think and try things out, patiently. It's not that bad, but does take a little time to work through the possibilities. There's no magic formula. Epidemiology involves collecting data and sifting through it. Start at the beginning and work your way through.

The diagnoses are all done after the epidemic is over. Everyone who is exposed gets sick and can pass on the disease. The exposure sequence goes left to right, and then down to the next individual. So, Patient 1 gives vegetables to Patient 12, then to Patient 14. Then Patient 2 gives vegetables to Patient 5, then to Patient 15. Then Patient 3 gives vegetables to Patient 6, then to Patient 16. And so on.

Note that Patient 1 never gets sick. Looking over the whole scenario, we see that Patient 1 shares vegetables with Patients 12, 14 and 4. Patient 12 does not get sick, but Patient 4 and 14 do. Where did they get the disease? First let's look at P-4, and if that doesn't work out, we'll come back and look at P- 14.

We see that P-4 first shared vegetables with P-1, but couldn't have gotten sick from that exchange as P-1 never gets sick. That also means that P-4 could not be infected at the time of that exchange. P-4 then shares with P-7 and then P-11. P-7 and P-11 both get sick, so one of them had to give the disease to P-4, because P-4 doesn't share veggies with anyone else. But which one did it? Let's look at P-7 first, and if that doesn't work, come back and look at P-11.

In other words, we'll test the hypothesis that P-7 is Patient 0, the source of the infections. The first step checks out, because the first time P-7 shares, it is with P-4, who gets sick. P-4 then shares with P-11, who also gets sick. P-7 next shares with P-2 and P-8. Do they get sick? Keep working through the interactions of P-7 and the people P-7 interacts with, and see whether or not they get sick. If, at the end, all the people who should get sick do, and all of the people who shouldn't don't, P-7 looks like the source. If P-7 doesn't fit, go back and see if P-11 works.

The Hitchhiker's Guide also says "It is a mistake to think you can solve any major problems just with potatoes". Good advice, as far as it goes, but assuming these people were passing around potatoes, just follow who gives potatoes to whom, and whether or not they get sick, and you'll be fine."

The Assignment:

1. From the data, determine the disease path of transmission (show your work, **see example on next page**)
    a. These people became infected: (1 pts)
    b. These people were not infected: (1 pts)
    c. Source of infection: Patient # _____ (5 pts)
    d. Show the path of transmission (written or diagram format; see example below): (3 pts.)

2. For this example, finding the source of the infection may not be that important, as the epidemic seemed to have stopped. But for more serious diseases, or longer running epidemics, why might it be important to know the origin? (3 pt.)

3. In the norovirus example, what preventative measures could have been taken to avoid exposure to infection? (2 pt.)

The Data:

Patient Number	Who did the patient give produce to, in the order they gave it?	Did the patient get ill?
1	12, 14	No
2	5, 15	Yes
3	6, 16	Yes
4	1, 7, 11	Yes
5	10, 3, 16	No
6	13, 2	No
7	2, 8	Yes
8	3, 10	Yes
9	15, 5	Yes
10	9	Yes
11	14	Yes
12	13, 15	No
13	16, 3	Yes
14	9	Yes
15	16, 5	No
16	9	Yes

Example of a similar problem:

Patient #	Produce sharing: (correct order if more than 1 person)	Did the patent get ill?
1	10	No
2	5 then 8	No
3	1 then 6	Yes
4	7	No
5	2 then 9	No
6	4	Yes
7	2 then 8	No
8	4	Yes
9	1 then 5	No
10	8	Yes

Looking at the "clean" vs. "contaminated" individuals, go down the student list and ask whether each person could possibly have been the "source". Remember the SEQUENCE of events is important:

#1: No (tested negative)
#2: No (tested negative)
#3: No (met #1 who tested negative, 6 tested positive, but maybe the source)
#4: No (tested negative)
#5: No (tested negative)
#6: Maybe (6 tested positive after sharing with #4; #4 tested negative after sharing with #7)
#7: No (tested negative)
#8: No (tested positive after sharing with #4; #2 and #7 were negative after sharing with #8)
#9: No (tested negative)
#10: No (tested negative after sharing with #8; #1 was negative after sharing with #10)

#6 seems to be the "source" of the infection.

Path of transmission (written format):
When 1 shared with 10, they were both OK.
When 2 shared with 5 and 8, they were all OK.
When 3 shared with 1, they were okay, but when 3 shared with 6, 3 got infected by 6.
When 4 shared with 7, both were OK.
When 5 shared with 2 and 9, all were OK.
When 6 shared with 4, 6 tested positive because 6 was the source.
When 7 shared with 2 and 8, all were OK.
When 8 shared with 4, 8 tested positive because 4 was infected by 6.
When 9 shared with 1 and 5, all were OK.
When 10 shared with 8, 10 tested positive because 8 was infected by 4, and 4 was infected by 6.