Epidemiology

Epidemiology is the study of the source, spread, and control of disease in a population. Etiology is the source of a disease outbreak within a population. An epidemic is defined as an increase in the occurrence of a disease over a given time, within a specific area or affecting a particular population. The role of an epidemiologist is to collect pertinent information about an epidemic – the causative agent, number of cases, the location and history of the disease, contributing factors, etc. These details become valuable in controlling progression of the epidemic – whether it involves development of a vaccine or other therapeutic agent, or the quarantine of infected individuals. Depending upon the morbidity rate or mortality rate of the disease, strict measures may have to be implemented to control it. US public health departments (e.g. CDC, NIH) are required to track and report many communicable diseases, e.g. avian flu, cholera, hepatitis, syphilis, etc. Morbidity rate is the percentage of people that become sick from a disease within a given population. Not everyone exposed to pathogens necessarily become ill. Mortality rate is the percentage of people that die from a disease within a given population. In general, morbidity rate is always much higher than mortality rate. For example the yearly morbidity rate for the common flu (influenza) in the United States ranges between 5 – 20%; whereas the mortality rate for the flu is much lower at 0.02%*. Collectively, of all this epidemiological information is critical in guiding the decisions of health care officials, like the Centers for Disease Control (CDC) in response to disease outbreak. In this experiment, we will simulate an infectious epidemic in the class. Your objectives will be to (1) analyze the source and transmission of the epidemic and (2) predict its impact on the class based on trends in its progression.

[*The Centers for Disease Control and Prevention (CDC), National Center for Health Statistics, Division of Vital Statistics, National Vital Statistics Reports (NVSR) Volume 61, Number 4, Table 19, May 8, 2013.]

Procedure

1. Each student is given a plastic Falcon tube (labeled with a number) that is filled with 14 ml of a clear solution that represents his/her “bodily fluid”. Using a clean transfer pipette take half a dropperful of your fluid and add it to a clean glass test tube (labeled 0) BEFORE you exchange fluids with another person. This will be your initial bodily fluid sample.
2. When given the signal by the instructor, each student will use a clean transfer pipette to exchange ‘fluids’ with someone at their table by putting a dropperful of his/her own solution from their Falcon tube into the other person’s Falcon tube. Cap and mix your solution after the exchange. Each person should only make one contact during this round and should record the name of the contact. [CAUTION: Avoid contact of the solution with skin. If you do, rinse with water and wipe up any spills on table or floor.]
3. After this first exchange, add a half dropperful of your fluid to a clean glass test tube (labeled #1).
4. At the instructor’s signal, each student should find a second contact, exchange one dropperful of their Falcon tube solution to another student’s Falcon tube, and record the name of the contact. Cap and mix your solution, and then add half a dropperful of that solution to a clean glass test tube labeled #2.
5. At the instructor’s signal, each student should find a third contact, exchange one dropperful of their Falcon tube solution to another student’s Falcon tube, and record the name of the contact. Cap and mix your solution, and then add half a dropperful of that solution to a clean glass test tube labeled #3.
6. At the instructor’s signal, perform a fourth exchange. Your falcon tube will now serve as tube #4.
7. After 4 rounds are completed, you will add a diagnostic indicator to all test tubes (glass tubes 0, 1, 2, &3 and the Falcon tube) to test for infection. The solutions of infected individuals will turn bright pink compared to the rest which remain yellowish/orange.
   [The diagnostic indicator is phenol red, which will turn an alkaline solution (pH > 8.2) bright pink.]
8. Pour out solutions in test tubes down sink, rinse well, and invert tubes upside down in rack to dry.
9. Working together as a class, try to analyze the spread of infection and answer the questions below.
Table 1. Infections

<table>
<thead>
<tr>
<th>Sample</th>
<th>Had Contact With:</th>
<th>Infected? Check the box:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>0 = original body fluid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 = first exchange</td>
<td></td>
<td></td>
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<tr>
<td>2 = second exchange</td>
<td></td>
<td></td>
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<tr>
<td>3 = third exchange</td>
<td></td>
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<tr>
<td>4 = fourth exchange</td>
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</tbody>
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Questions

1. How many people were infected after
   a. round 1?
   b. round 2?
   c. round 3?
   d. round 4?

2. Can you predict the identity of the original infected individual?

Graph below the number of infected individuals per round, for all four rounds of contact.

3. Now use the data to predict the number of infected individuals after 5 rounds of contact.____________________

4. What is the morbidity rate for the class?____________________
Theoretical Versus Actual Spread of Infectious Disease:

The graph below describes the difference between theoretical spread of infectious disease and actual spread of infectious disease. In a population with very few infected individuals, the disease spreads rapidly to newly infected individuals. When the number of individuals is plotted against the number of interactions per individual, the result is an exponential growth curve. Essentially, the exponential growth curve predicts an infinite and “theoretical” increase in the rate of disease transmission due to an unlimited potential number of new people in a population that potentially can become infected. In reality however, the actual rate of disease transmission is limited by the number of newly infected individuals. To put it another way, disease transmission becomes limited because infected people cannot spread the disease to other people who are already infected. So in real world situations, the exponential curve gives way to a logistic growth curve, which becomes less steep as the number of infected increases. Examples of the two curves are show below. Notice that both are very similar when the number of interactions per person is low, but as that number climbs, the logistic curve flattens away from the exponential.

Why would it be considered normal for the number of infected individuals to not reach its maximum (total number of individuals in population)?