ES Epidemic Simulation

Learning Objectives

The student will

- Use aseptic techniques in the safe inoculation of various forms of media.
- Follow oral and written instructions and manage time in the lab efficiently.
- Apply epidemiological terminology to case studies.

Background/Theory

**Epidemiology** is the study of how a disease moves through a population. It concerns the geographical distribution and timing of infectious disease occurrences and how the disease is transmitted and maintained in nature, with the goal of recognizing and controlling outbreaks. The science of epidemiology includes **etiology** (the study of the causes of disease) and investigation of **disease transmission** (mechanisms by which a disease is spread).

Two ways public health officials track a disease is noting its prevalence and its incidence. **Prevalence or point prevalence** is the number of individuals with a particular illness in a given population at a point in time. When expressed as a proportion of the susceptible population, it is termed the **prevalence rate**. **Incidence** is the number of **new** cases in a period of time. **Incidence rate** is the incidence expressed as a proportion of the population. These two statistics are usually expressed as # cases per 100,000 persons (or other suitable number). Diseases for which a larger than expected number of cases occurs in a short time within a geographic region are called **epidemic diseases**. Influenza is an example of an epidemic disease. Incidence patterns of influenza tend to rise each winter in the northern hemisphere.

Epidemics can be classified by how the disease is spread in the **population**. A common source (or point source) epidemic originates from a single source for all of the individuals infected. A recent outbreak of Salmonella illnesses linked to contaminated chicken salad (US Centers for Disease Control and Prevention) is an example of a common source epidemic. As of March 26, 2018, 170 people in 7 states have been affected. Point sources often lead to large-scale but localized outbreaks of short duration.

In contrast to common source spread, **propagated spread** occurs through direct or indirect person-to-person contact. With propagated spread, there is no single source for infection; each infected individual becomes a source for one or more subsequent infections. With propagated spread, unless the spread is stopped immediately, infections occur for longer than the incubation period. Compared to a point source epidemic, a propagated epidemic typically leads to an outbreak of longer duration that can vary from small to large. In addition, propagated spread cannot be easily stopped at a single source like point source spread. Examples of propagated epidemics include seasonal influenza, sexually transmitted diseases and the Ebola epidemic in western Africa. In a propagated epidemic, the first case of the disease in the population is called the **index case**.

An individual capable of transmitting a pathogen without displaying symptoms is referred to as a **carrier**. A passive carrier is contaminated with the pathogen and can mechanically transmit it to another host without being infected. For example, a health-care professional who fails to wash their hands after examining a patient harboring an infectious agent could become a passive carrier, transmitting the pathogen to another patient who becomes infected.

By contrast, an active carrier is an infected individual who can transmit the disease to others. An active carrier may or may not exhibit signs or symptoms of infection. For example, active carriers may transmit the disease during the incubation period (before they show signs and symptoms) or the period
of convalescence (after symptoms have subsided). Active carriers who do not present signs or symptoms of disease despite infection are called asymptomatic carriers. Pathogens such as hepatitis B virus, herpes simplex virus, and HIV are frequently transmitted by asymptomatic carriers.

Regardless of the reservoir, transmission must occur for an infection to spread. Contact transmission includes direct contact or indirect contact. Person-to-person transmission is a form of direct contact transmission. Here the agent is transmitted by physical contact between two individuals through actions such as touching, kissing, sexual intercourse, or droplet sprays. Indirect contact transmission involves inanimate objects called fomites that become contaminated by pathogens from an infected individual or reservoir. For example, an individual with the common cold may sneeze, causing droplets to land on a fomite such as a tablecloth or carpet, or the individual may wipe her nose and then transfer mucus to a fomite such as a doorknob or towel. Transmission occurs indirectly when a new susceptible host later touches the fomite and transfers the contaminated material to a susceptible portal of entry. Fomites can also include objects used in clinical settings that are not properly sterilized, such as syringes, needles, catheters, and surgical equipment. Pathogens transmitted indirectly via such fomites are a major cause of healthcare-associated infections.

(OpenStax CNX)

Experiment/Exercise

**Materials per individual student**

1 solution tube
4 empty sample tubes
1 Pasture pipet
Iodine

**Cultures**

None

**Procedure**

1. Each student will be given a test tube containing a harmless, non-toxic solution. One of the tubes in the room is carrying the “disease.”
2. Take four clean test tubes and label them 1, 2, 3 and 4 to represent each week of the simulation. These are your sample tubes
3. With a clean pasture pipet, transfer one or two drops of your solution into sample tube number one. This tube becomes your record of your disease state in week 1. Leave the pipet in tube 1 as a holder for now.
4. When prompted by the instructor, mix your solution tube contents with another student’s solution tube. Pour one tube into the other and then pour half of the contents back into the first tube. Each tube should end up with approximately the same volume of liquid.
5. Place two drops of this mixed solution into sample tube 2 with your pasture pipet. Do not share a pipet with another student. This is a record of your disease state in week 2. Leave the pipet in tube 2 as a holder for now.
6. As the instructor prompts, repeat steps 4 and 5 two more times with different students.
7. To determine who is infected at the end of week 4, add a drop of iodine to sample tube 4 only. If you are infected, your solution will turn black.
8. Infected individuals will write their first name on the board along with the individuals they had “contact” with during the simulation.
Lab Report: Epidemic Simulation

Name ________________________________
Lab Section _________

Data and Observations
1. From the information on the board, draw a diagram showing the transmission of the disease through the population and identify the index case.

2. After completing step 8 above and being prompted by the instructor, add a drop of iodine to each of the other sample tubes and fill in the following chart for the class data.

<table>
<thead>
<tr>
<th>Week</th>
<th>New Cases</th>
<th>Total Cases</th>
<th>Incidence Rate</th>
<th>Prevalence Rate</th>
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<tbody>
<tr>
<td>1</td>
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Post Lab Questions
1. What terms introduced in the Background/Theory section can you apply to this scenario? Are there any other assumptions about the disease?
2. In the year 2000 the total US population was approximately 281 million. From the information in Figure 1, estimate the incidence rate and the prevalence rate (per 100,000) for HIV in the year 2000.

3. What might explain the upward trend in prevalence of HIV infections, while the incidence has remained fairly constant (since 1992)?
References
