TEACHING UNIT FROM THE ARKANSAS SCHOOL FOR MATHEMATICS AND SCIENCES

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Subject: Epidemiology
Applicable classes: Biology (general, honor's, or AP), Microbiology, Immunology, World History, American History, Mathematics

Purpose:

The purpose of this unit is to introduce the students to epidemiology, or the study of the infection patterns and rates of a particular disease. This unit can be used in several capacities and in several different classes, and can be modified in order to suit the target audience or particular school setting. Examples of its uses include: an introduction to bacterial or viral biology; an introduction to epidemiology; an introduction to basic statistics; an introduction or follow-up to a unit on plagues in the history of the world or the United States; as well as others.

Pre-requisites:

Although this unit could be used in almost any classroom to introduce epidemiology, there may be some benefits to having covered certain material prior to its introduction. For instance, students should be familiar with the following terms:

- *epidemic* –a disease occurring in a population at a rate higher than normal frequency
- *endemic* –a disease occurring at a low, but constant frequency
- *pandemic* –when the frequency of a disease increases throughout the world
- *sporadic disease* –affects a certain percentage of the population throughout the year
- *seasonal disease* –one that occurs during certain time of the year (usually due to a higher number of vectors during that season, i.e. Lyme disease, or a change in climate causing people to be in closer contact with one another, i.e. the common cold)
- *carrier* –any infected individual that continues to infect others (often suffers from subclinical or no symptoms of the disease)
- *reservoir* –animate or inanimate site where an infectious disease is maintained in nature between outbreaks
- *outbreak* –term used when there is a relatively large number of cases in a limited area
- *incidence* –number of newly reported cases per a given time in a population
- *mortality rate* --ratio of deaths from a particular disease relative to the total number infected
- *morbidity rate* --incidence of a particular disease in a population during a specified time period

Depending on the course in which this is taught, other appropriate topics to be familiar with might include *modes of transmission* (contact, sexually transmitted diseases, louse-borne, vector-borne, nosocomial infections, etc.) and *control measures utilized* (quarantine, vaccination, food and water measures, antibiotics, etc.)

Materials needed:
Prior to introducing this activity, I have my Immunology class prepare for it by making labels to be used in the actual outbreak (see description of scenario below). If you don't have class time to do this, you may want to prepare them yourself. Since we have approximately 300 students and staff members here at ASMS (everyone is involved in this activity), I have my kids make 50 "Quarantined" stickers, 200 "Infected" stickers, 200 "Dead" stickers, and 200 "Vaccinated" stickers. You should adjust these numbers according to the number of participants you have. I typically set a high mortality rate for the virus (85% or so), so you won't need as many stickers of each type as you have participants, since a good number of them will be "Dead", and others "Quarantined". The ones we use most are usually the "Vaccinated" stickers, because your CDC workers tend to go crazy vaccinating everyone to stop the disease from spreading. You can just print these on printer labels, or you can have your kids decorate and create signs to hang around the neck, pin on the shirt, or whatever you like.

Scenario:
Choose a class who will become your CDC (Centers for Disease Control) doctors. The day before the outbreak (or the week before if you want to keep them on their toes), you should explain the basics of the exercise. Tell them that a simulated outbreak is going to occur on your campus and they will be responsible for stopping its spread, quarantining infected individuals, vaccinating non-infected individuals, and eventually identifying patient "zero". Tell them that they will be armed with labels of various types to give to all participants, depending on their fate. Meanwhile, you choose a faculty or staff member to serve as *patient zero*, and tell them at some particular time (that only you and they know about) they are to announce to their class, or to those that they come in contact with initially, that they are now "vectors" of the disease. The vectors can carry the virus, but do not suffer from its symptoms. Each vector is given a die and several labels that say "Dead". They are then to walk up to unsuspecting victims and let them roll the dice. Since the mortality rate is 85% (you can change this if you like), the person must roll a specified number in order to live. Any other number results in their death, and they get a "Dead" label. If they live, they get no label, but get to go infect others. Since you probably don't have enough dice to go around, just tell your vectors to instruct all those they infect to pick a number between one and six (and keep it secret), then let their victims choose a number between one and six. If the victim chooses the correct number, they must continue the infection pattern. If they choose any other number, they are given a "Dead" sticker.

Your CDC doctors need to make nametags indicating they work for the CDC (they love that), and are automatically vaccinated. They each get several "Vaccinated" stickers and several "Quarantined" stickers. When the outbreak occurs, they should go out and vaccinate as many people as they can. Once a person is vaccinated they can't be infected or infect others. The tricky thing is that they might vaccinate a vector, but of course won't know it (vectors never reveal their identity). And since the vaccine only works on people who haven't been infected yet, the vectors can continue infecting others. Only if a CDC worker realizes someone is a vector (usually by seeing them

infect someone), can that person be "Quarantined". Once quarantined, a vector can no longer infect anyone. By the end of the day, everyone will be vaccinated, quarantined, or dead. The CDC workers must then calculate the mortality rate, morbidity rate, and incidence of the disease based on the results. They should also attempt to identify patient zero.*

Before the outbreak takes place, alert the faculty, staff, and students that an outbreak is going to occur soon, and that these rules must be followed:

1. Once they are given a "Dead" sticker, they cannot remove it and continue playing.
2. Once "Quarantined", a vector cannot continue to infect others.
3. No one can identify the person who infected them to the CDC, since in a real-life situation it is unlikely that people know exactly where they contracted a particular disease.
4. Vectors cannot disclose the identity of patient zero (patient zero and the vectors should be encouraged that they are on the same "team", and it's their mission to infect and kill as many people as possible).
5. CDC workers can interview survivors to determine whom they came in contact with, but cannot ask who infected them or who patient zero is. Our kids usually figure out who patient zero is by discovering who the vectors are then figuring out what class they have together.

I usually let this take place over an entire school day. I have patient zero (usually a teacher) infect one of their morning classes and send them on their way to infect others. By the time the CDC workers realize that the outbreak is happening, several people are already dead or are infecting others. I try to do it at a time that catches them off guard. For instance, I teach Immunology 5th period. I usually warn them a week in advance that the outbreak will take place "sometime in the next week". Then on a day that I don't even have 5th period (we have a block schedule), or at some time other than 5th period, I have patient zero begin the outbreak. If you want to make it more interesting, you can "mutate" the virus in the middle of the day (I usually announce it at lunch), which means that the current vaccine no longer works, and all those who were vaccinated can now become infected again. That means the CDC workers have to go around vaccinating all those people again, and the mortality rate usually goes up at that point. Below is the letter I place in the faculty and staff mailboxes prior to the outbreak. I also have attached an "official CDC bulletin" that I give to my Immunology class on the day of the outbreak.

* This is a perfect opportunity to introduce famous outbreaks and plagues of the past. Examples include Typhoid Mary, John Snow and the Cholera outbreak in London, the Bubonic Plague (which has occurred on several continents in several different centuries), malaria, smallpox (this is a good one because it was the first disease to be eradicated from the Earth in 1977), AIDS, tuberculosis, the Spanish Flu (a very strange and interesting disease—it appeared and inexplicably disappeared in 1918, leaving anywhere from 20 to 80 million people dead, more than all modern wars combined!!)

This is the letter I place in faculty/staff mailboxes:

OUTBREAK!!!

This activity will involve the entire student body, faculty and staff at ASMS. Periodically students, teachers and staff members will be informed that they have particular symptoms, and will be told where they may have possibly become infected. Mr. Willbanks' Microbiology/Immunology class will act as the CDC (Centers for Disease Control) and will begin tracking the virus in hopes of identifying patient zero and eventually containing the outbreak before the population of ASMS is wiped out.

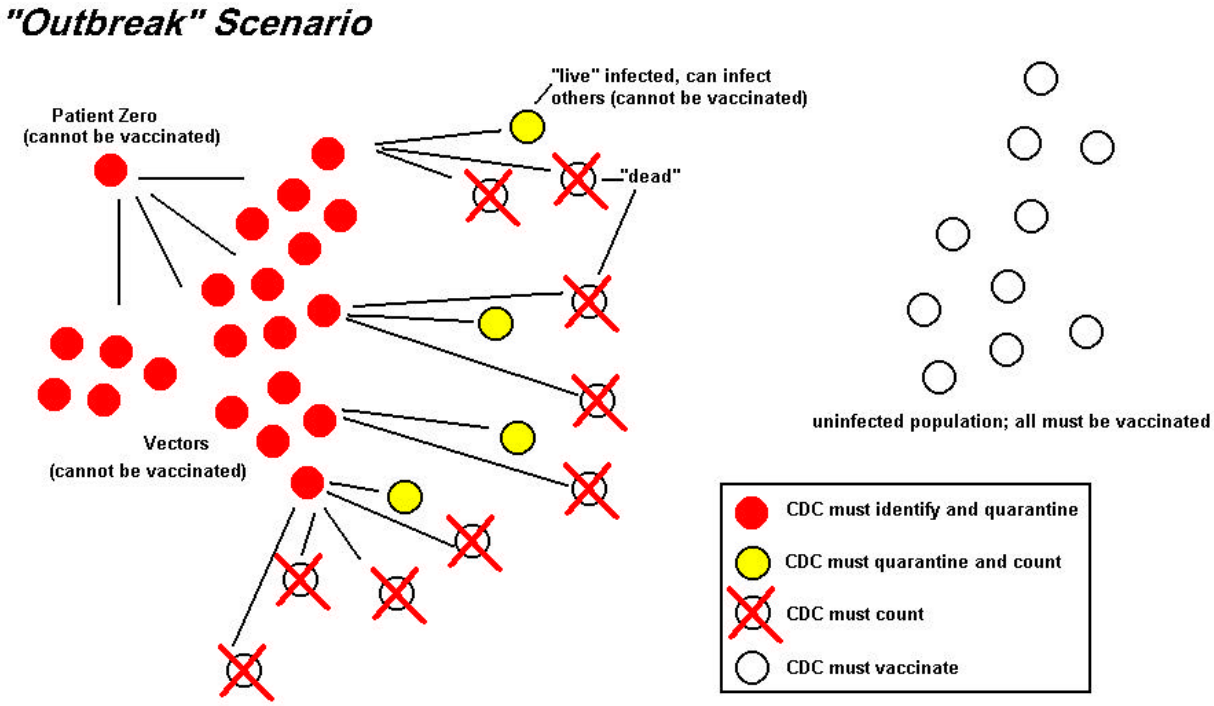
Scenario:

Insert teacher or staff member's name is patient zero. He has a peculiar strain of an avian influenza A (H5N1) virus that was previously identified in Hong Kong in 1997. He traveled to Hong Kong in November of 1997, and was infected with the virus then. He had onset of symptoms in early December 1997, and was fully recovered by January 1998. In the past three years, he has been carrying the virus, and it has undergone "antigenic drift" (meaning it has mutated and is slightly different than it was originally). He recently came down with a cold, and this compromised his immune system, allowing the dormant virus to re-emerge. He is now carrying the virus, but is not suffering from symptoms of the flu. Since he has a cold, he is actively infecting those he comes in contact with. After initial infection of a small population called the "vectors", the mortality of this virus has risen to 85% (*feel free to change the name of the virus or any other specifics to suit your needs*).

During his first period class, patient zero will inform his students that he has a virus, and they are all now infected. These students will be the "vectors". For the rest of the day, they will randomly choose individuals (students, faculty, or staff) they come in contact with and inform that person that they have a virus and have just infected that person. That person will then roll a dice to determine if they live or not. If they roll a four, they live. Any other outcome results in their death. They will then be given a badge to wear that will indicate that they are infected, and whether they are alive or dead. If they are alive, they will continue to infect others, following the same procedure as above. Meanwhile, students in the Microbiology/Immunology class will be issued a report from the CDC indicating that there is an outbreak at ASMS, and that they suspect, but cannot confirm, that it is an avian influenza virus. They have developed a vaccine consisting of all known active influenza strains, and preliminary tests indicated that the vaccine is effective in stopping initial infection, but has no affect on persons already infected. They will then be charged with several tasks. They include: 1) vaccination of all persons on campus, 2) identifying the vectors, 3) quarantining vectors and "live" infected victims, and 4) identifying patient zero.

The "CDC doctors" will be encouraged to interview all infected (living) patients to determine who might have infected them. They can only ask the patients whom they have come in contact with so far that day. They cannot specifically ask who infected the patients because the likelihood of them knowing that would be small in a real

outbreak. They will also be encouraged to quarantine infected patients. In order to do so, they will simply give them a badge to wear indicating they have been quarantined. That person can no longer infect other people. By the end of the day, the entire population will either be dead, quarantined, or vaccinated. The students will then begin compiling their data and information to determine the identity of the vectors and patient zero.



Below is the letter I give to my Immunology class on the day of the outbreak.
(I made up the logo, so there is no need to copyright it)

CENTERS FOR DISEASE CONTROL AND PREVENTION
ATLANTA, GA

August, 17, 2000
Regional Office
Little Rock, AR

Alert Message 1:

The CDC Regional Office in Little Rock suspects the possibility of an outbreak of Avian Influenza A, strain H5N1 in your area. Results of Western blot analysis and gene sequencing from infected patients in Little Rock are unavailable at this time, but will serve to confirm the identity of the virus. The origin (patient zero) is unknown. The vectors, other than the two patients in isolation at UAMS, are unknown.

Doctors at Arkansas Children's Hospital have developed a preliminary vaccine (FluVac1A) to be administered immediately to anyone in the local vicinity to prevent further spread of the virus. It should be noted that preliminary tests indicate that the vaccine will prevent initial infection, but has no affect on infected patients.

Your team of physicians is urged to do the following:

1) Locate, identify, and quarantine patient zero,
2) Vaccinate all persons in the vicinity,
3) Quarantine any infected patients and treat symptomatically.

The CDC Regional Office will update you as soon as possible. Please report the results of your efforts on, Monday, August 21, 2000.

—End of message—