This module will provide you an overview of outbreak investigation, an area many students find interesting.

This slide shows an overview of the steps in conducting an outbreak investigation. We conduct outbreak investigations to identify the cause of a disease, and hopefully stop its spread and prevent further disease. This is the part of epidemiology that students find fascinating. There are a total of 10 steps in an outbreak investigation, divided into 5 phases. Each one is described in more detail on additional slides. The first two steps use descriptive epidemiology and in the later steps we are using an analytic approach. Click on the boxes to learn more about each step.

Outbreak investigation steps 1-3: This step deal with some of the practical issues. You need to prepare for field work and develop a team. You want to consider who you will need and what equipment you will need. Obviously the area in
which the epidemic occurs is very important. If
the area is in a remote village in Africa, you will
need different supplies and people than if it is in a
large US city. You also need to consider how
severe the epidemic is, what the potential may be
for spread, both within the community as well as
to people on the medical team. It is important to
consider how much concern there is in the
community and the best way to interact with the
community. Ideally, you want a contact person
from the community who knows the community
well and can assist with communication among
the people there. And you need to plan for what
resources you might need and where they are
available so you know what you need to bring
with you and what can be done back at your
home base. Electricity, water, and
communication resources will all be very
important.

**Outbreak steps 4-5:** One of the first things you
need to do is to identify a case definition for your
outbreak. You are going to do this based upon
the symptoms the initial people have. Ideally
what you want to be able to do is to accurately
describe the cases of disease. Often at the start
of an outbreak investigation, since you may not
know the disease you are investigatin
g, you identify cases based on symptoms. You may
have some suspicions as to what the disease is
based on prior outbreaks or knowledge of the
types of diseases that occur in this setting. Start
by looking at the cases in terms of time, person,
and place. You might identify an index case that
is the person who had the disease before the
others. An investigation into this person might
give important clues as to the cause of the
epidemic. Click on the word Index for a link to the
description of the index case in the 2014 Ebola
epidemic.

You draw an epidemic curve from the people in
your study. You do this by putting time on the x
axis and the number of case on the y axis and
just plot them against each other. These curves
are very important in giving you information on
the type of disease transmission you are dealing
with. Is it likely from a single exposure, for
example, bad food at a college picnic, or is there
evidence of continuing exposure, perhaps a
contaminated water source, and is there evidence
of person to person spread? The link under epidemic curve is to a site by the University of Ottawa that describes the different types of epidemic curves you obtain and what they might mean.

**Outbreak Step 6:** At this point, you need to Develop a hypothesis. Use the epidemiology triangle if you believe it is an infectious disease. You need to ask yourself some questions: Why was the agent present? What made it dangerous? Who was exposed? When and How? Who got sick and how sick did they get?

There are other factors that can contribute to the spread that you will need to consider but for the moment you need to focus on trying to identify the specific agent, to come up with a working hypothesis that you can test. But when you try to identify how people were exposed, you do need to understand the culture of the group you are working with. Culture does not just refer to some distant group. We have our own culture and this impacts on the decisions we make. The cultural practices most invisible to us are our own. I have also included a very interesting link to a CDC blog on the zombie apocalypse. I think you will find it informative.

**Outbreak step 7:** In this phase, you need to evaluate your hypothesis by conducting an analytical study. This can be done in two ways: the first is to conduct a case control study, comparing those who became ill with a group who did not become ill. This is the most common approach, especially if we are unsure of the cause of the disease. It is also possible that you might conduct a cohort study if for example, you thought that people in a certain group were exposed to some agent and you wanted to compare their health to those not exposed. There are two measures we commonly use in outbreak investigations. The first is the attack rate and the second is a case fatality rate. The attack rate tells us more about the association of hypothesized exposures with the disease and the case fatality rate addresses the severity of the disease. The attack rate is calculated by dividing the number of people of people who got sick by the number who had a given exposure. This is
then compared to the number of people who got sick and who did not have a given exposure. If we compare the rate of illness among people who had different exposures we can determine the cause of the illness. I will give you a chance to practice this in a later slide. The case fatality rate is used to determine the severity of the disease. We want to know of the people who had the disease, how many died. If you click on the cruise ship, it will take you to a link of a video on attack rates and case fatality rates by Dr. Patwari.

Once we have our hypothesis, we conduct systematic study. We usually use a case control approach comparing those who are ill with those who are not. If the illness seemed to result from a discreet event, like a COPH picnic, then we can compare those who attended who were sick with those who attended but were not sick. The goal is to test our hypothesis and obtain evidence for identifying the causative agent. Sometimes we are not successful, and sometimes it takes a long time before we get any answers.

Attack rates are fortunately easy to calculate. You simple identify who is sick and who is not and then determine the exposures you want to evaluate. You calculate an attack rate for each those sick who were exposed and sick who were not exposed, by dividing the number of sick by the number exposed and the number sick by the number not exposed for each suspected item

**See slide for equations**

Then you compare the two by dividing the attack rate in those who were exposed by the attack rate among those not exposed and Look for the
exposure with the highest ratio between the two calculations.

It is easier to understand this in terms of a food borne outbreak. Let’s say some people attending a community supper became ill. The problem in identifying what caused the illness is that people ate different combinations of food so what you need to do is collect a food diary and then look at each food separately. You calculate the attack rates among the participants exposed and not exposed for each food and then compare the ratio of the attack rates between the two groups. So let’s try an example.

Here is an example of an attack rate calculation. It is from a CDC exercise that was from an actual outbreak investigation of people who attended a church supper in Oswego, N.Y., and developed a gastrointestinal. This table compares the attack rate between people who ate certain foods and those who did not. Look at the baked ham. 42 people ate the ham and 21 did not. Of the 42 who ate the ham, 59.2% became ill and of the 33 people who did not eat the ham, 63.64% became ill. The attack ratio of 0.94 is less than 1 and clearly indicates that ham was not the problem.

We can do a similar exercise with the spinach. Divide the 27 people who ate the spinach and became ill by the total number who ate the spinach, 45, which equals 60%. Do the same for those who did not each the spinach. Divide the 19 ill by the 30 people who did not eat the food which equals 63.3%. Divide 60 by 63 which equals 0.95, again a number less than 1, so the spinach was not the problem. Now you do it for the mashed potatoes. Calculate the attack rate among those who ate the potatoes with those who did not eat the potatoes and enter the attack rate ratio in the box.
Here are four boxes for each type of epidemic. Drag the picture of the epidemic curve into the correct box and then drag in the description of the epidemic into the matching box as well. Good luck. Use the article on epidemic curves if you need help with this exercise.

This is the correct answer. A continuing source epidemic will have a prolonged exposure. This could be an ongoing contamination of water for example but it does not have person to person spread. An intermittent epidemic is a common source but the exposure occurs at intervals, possibly from an occasional release of a chemical exposure or due to changes in the environment, such as weather and rainfall. There is no person to person spread. Propagated is a person-to-person spread of disease and thus there is the greatest risk of widespread disease, as the exposure is not limited to the area in which it first occurred. Point source is the single exposure from a one-time event without future person to person spread.

**Definition:** Two or more cases of a relatively uncommon disease related in time and place, and perceived to be of greater frequency than expected by chance

Identified when individuals note an increase in the number of cases of a disease. These are often reported to the health department.

**Many challenges**
- Usually disease is rather rare, making traditional statistical methods difficult to apply and adequate power is difficult to achieve.
- Case definitions are often imprecise - may represent several diseases, each with its own cause(s).
- Often impossible to identify an appropriate population at risk from which to develop incidence rates.
- Long latency periods between exposures and outcomes.
- However, much controversy, particularly among the public.
the cases and it can be fairly wide. And there may be unusual diseases noticed in very different populations. It makes it difficult to conduct a study as well as to have a control group to compare the results to.
• Long latency periods between exposures and outcomes. So if people moved in and out of the area, they may have been exposed elsewhere.
• However, there is much controversy and concern, particularly among the public. And this is understandable. There have been a few clearly identified disease clusters. Click on the picture to see some examples.

• There are not many true disease clusters that are identified based on research but there have been some notable ones. They generally are environmental exposures looking at toxic substances. One of the best known was the contamination from the Pacific Gas and Electric Company that was shown in the Erin Brockovich movie. You might want to see this movie at some point as it is pretty interesting. I have attached a link to a PBS report on the true outcome of this story. Politics is clearly a factor in public health decisions. I thought you might find this report interesting. Just click on the True Erin Brockovich story link to obtain more information.