[Narrator] During the COVID-19 pandemic, you might remember seeing news reports showing graphs that looked like this or hearing the phrase “flatten the curve.” You might have wondered, what are these graphs showing and why do we care about these curves?"

These curves represent a lot of data and these data would be much harder to understand if they were presented in a list or table. It is more difficult to see patterns when you are staring at columns of numbers. Graphs--like these curves-- illustrate data in ways that are easier for people to understand. They make patterns more recognizable and can help lead to questions for further analysis.

To keep the public informed about current disease spread and trends, public health experts often share public health data.

As public health workers collect data to monitor disease occurrence in the community, they summarize the data and create different types of graphics. These data visualizations help both the public health experts and the public understand the information.

Here’s Harper, a health communication specialist. They often use data visualizations to communicate disease information. Harper shares these visualizations with the local community through the health department’s website, TV news and radio stations, and on social media channels.

Depending on the data, Harper can use different types of graphs and other visuals, such as bar graphs for comparing data, line graphs for showing trends over time, area maps for showing the rates of a health condition in different areas, and histograms for showing the distribution of data.

One of the most common graphs used in epidemiology is the epidemic curve, or *epi curve*, for short.

An epi curve is a histogram that displays the number of new cases of disease over time.

How is a histogram different from a bar graph? As you can see, the bars in a histogram touch, but in a bar graph they usually do not. That is because the x-axis of a bar graph represents separate categories of data, such as county of residence or favorite ice cream flavor. These categories are distinct from one another, so the bars are separated.

On the other hand, with a histogram, the x-axis represents continuous data, such as weight, height, quiz scores, or time. When displaying continuous data, you must select equal category ranges, such as the percentage point intervals between 70 percent and 80 percent, 80 and 90 percent, and so on for each category. Because each category of continuous data runs up to the next, the adjacent bars touch.

Let’s look more closely at the two axes of an epidemic curve.

The y-axis represents the number of new cases of the disease. Usually, this is the number of new cases reported to or identified by the health department. For some epi curves, the y-axis represents the number of hospitalizations or deaths due to a disease depending on what health experts want to show.

The x-axis represents the time period during which the new cases occurred. Traditionally, cases are categorized by date or time when symptoms began. This is called “time of onset of illness”. Cases may also be categorized by “date of report”. Depending on the disease and the situation, the categories on the x-axis can be hours, such as for a local outbreak of food poisoning, or days, weeks or longer, such as for a long-lasting flu epidemic or pandemic.

You can learn a lot about an outbreak from an epi curve. You see the distribution of cases over time and whether there are cases that stand apart from the overall pattern. These are called “outliers”. These may provide information on how the outbreak started. You get a sense of the magnitude of the outbreak and whether cases are increasing, decreasing, or if the outbreak is over. Sometimes, you can also make inferences on the outbreak’s pattern of spread and even determine the most likely time of exposure.

Harper can use what’s learned from an epi curve to communicate important information to the public. For example, pointing out that the spread of an infectious disease has increased drastically as shown by the epi curve rising sharply, or confirming that a prevention strategy like physical distancing, wearing masks, or vaccination is working well by showing the number of cases falling sharply!

So, what does it mean to “flatten the curve,” as we heard in news reports during the COVID-19 pandemic? The phrase “flatten the curve” has been used widely to describe the effects of prevention strategies on a disease event. In an outbreak with person-to-person spread but without any prevention strategies, there can be many cases over a short period of time—perhaps even more cases than the existing health care system can handle at once! This epi curve shows us that the number of cases currently is more than the healthcare system can manage.

To flatten this curve, prevention strategies can be put into place to slow the spread of disease and decrease the number of cases occurring at the same time. Also, flattening the curve allows additional time for the development of treatments and vaccines which will also help decrease the total number of cases and minimize further spread.

Speaking of disease spread, outbreaks can have distinct patterns, depending, in part, on the mode of transmission, or how the agent spreads. These are reflected in the shape of the epi curve and can give epidemiologists some idea of how the disease is spreading through the community. There are four types of epi curve patterns including: point source, continuous common source, intermittent common source, and propagated.

Let's talk about each one.

The first pattern is a point source outbreak. In a point source outbreak, people are exposed to the infectious agent from a single source at a single point in time such as a company picnic or wedding reception. The time interval between exposure and onset of symptoms is called the incubation period. People exposed at the same time get sick within one incubation period of exposure.

For *Bacillus cereus* food poisoning, the usual incubation period is 1–6 hours and illness lasts about 24 hours; so, all cases would be expected to occur during that time period. The resulting epi curve for a point source has only one peak — usually a sudden upward slope followed by a gradual downward slope covering one incubation period.

A great example of this is when everybody eats the same contaminated food at a large event, like a wedding reception. Only the wedding guests get sick and the disease is contained within one, limited time period. Of course, this is just a general rule, because it's also likely some guests may take home leftovers, eat them a few days later, and get sick outside the expected time period.

When the exposure lasts longer than just a single point in time, it can cause a continuous common source outbreak. A single source of the infectious agent is involved, but exposure takes place over a longer period. As a result, cases are spread out over time. For example, there was a multistate outbreak of *Salmonella* infections linked to raw turkey. People reported exposure to many different turkey products. For example, some people ate turkey products, others were exposed while preparing raw turkey pet food, and some people were infected through contact with live turkeys. This suggested widespread contamination not only where there were live turkeys, but also where turkey products were produced, resulting in cases that occurred over a longer period of time as compared with a point source exposure.

The epi curve for a continuous common source outbreak usually presents as a long, bumpy plateau of cases lasting more than one incubation period rather than a single peak. It theoretically starts with the shortest incubation period after the first exposure and ends after the longest incubation period for the last exposure.

Sometimes an exposure is not continuous but intermittent, usually at irregular intervals over time. The epi curve for an intermittent common source outbreak usually includes multiple peaks with valleys when there are fewer or no cases.

Consider, for example, a roadside spring that becomes contaminated after heavy rains. People go there to fill jugs of fresh spring water to drink. Those who go during dry spells are fine but those who go after a heavy rain become ill after drinking the water. Only one source is involved, but the infectious agent is not always present—it is intermittent which means it happens once in a while and not in a regular interval. The epi curve in this situation would represent a series of cases peaking after heavy rains with few or no cases during dry periods.

The final type of outbreak spread is called propagated. In epidemiology, propagated means that an infected person transmits the disease to other people, and each newly infected person can transmit it to others. Ebola and measles are examples of diseases that spread this way.

Propagated outbreaks are different from the other three, because instead of resulting from a common source like food or water, they result from person-to-person spread.

The classic epi curve of a propagated outbreak usually has two or three peaks representing exponential spread until the outbreak reaches a steady maximum point, known as a plateau, or the outbreak ends. The distance between these peaks can give a rough estimate of the incubation period for the infectious agent. Sometimes each peak is larger than the previous one, because each of the infected people can spread it to multiple others. And sometimes, over time, there is so much spread that the peaks can even start to overlap, resulting in the plateau shape.

As a quick recap, we can now answer the question “How are public health data visualized”? Graphs and maps are examples of data visualizations that help to make data easier to understand and use. One common data visualization used in public health is an epidemic or epi curve. An epi curve is a histogram that displays the number of new cases of disease that are occurring over time. Epi curves are essential for showing the timeline and course of an outbreak, including whether the outbreak is on the rise, on the decline, or over. Sometimes, the pattern of the epi curve can be used to make inferences, or draw conclusions, about the outbreak’s timing of exposure and spread.

There are four types of epi curve patterns. These patterns reflect how and when people are exposed to the source. Point source, continuous common source, and intermittent common source all describe outbreaks that can be traced back to a common source of the infectious agent. Exposure in a point source happens at one point in time, continuous happens consistently throughout a specific period, and intermittent happens at different intervals of time. Propagated outbreaks describe person-to-person transmission and these epi curves may have taller and taller peaks over time. Prevention strategies aim to reduce the height of these peaks and this is often described as “flattening the curve”.