**Transcript for P-chart**

FARROKH ALEMI: This lecture was organized by Dr. Alemi. The purpose of P-charts is to analyze binary outcomes over time, such as mortality, infections, or medication errors. P charts can also be used to examine percent of our population with a particular characteristic, such as the percent satisfied with care or percent diabetics under control.

The assumptions are that the outcomes should be dichotomous, meaning there should be only two events. These events should be mutually exclusive, meaning that the two events could not occur together. Mortality is a good example. One cannot be dead and alive at the same time.

These events should also be exhaustive, meaning that one of the two events must always occur. Keeping with our example on mortality, one is either dead or alive. One of these two events must have occurred. The observations over time should be independent, meaning that events in one time period should not change the rate of events in another time period. For example, the assumption of independence is violated if patients in current time period can infect future patients.

We are assuming that case mix does not change over time. The nature of the patients we are seeing in different time periods should be the same. They are not sicker or healthier in one or another time period. Finally, we also assume that the sample represents the population. This is a complex assumption and includes assuming that during the time period we collected data, we did not have a change in the underlying care processes.

Let us go through the steps for construction of P-chart. First, we calculate the grand rate. This is the total number of events across time periods divided by the total number of cases across all time periods. This statistic is calculated across all time periods. Next, we calculate the standard deviation. The square of the standard deviation is the grand rate times 1 minus the grant rate divided by the number of cases in the time period.

The upper and lower control limits for each time period are calculated from the rate across the time periods and standard deviation within that time period. In the last step, the chart is drawn interpreted, and distributed to improvement teams.

We will demonstrate the creation of P-charts by analyzing these eight time periods. Note that for each time period, we see the number of cases and the number of deaths. That's the data needed for the P-chart. The observed rate of mortality for each time period is given by dividing the number of deaths in a time period to the number of cases in that time period. For example, the observed rate of mortality in the first time period is calculated as 49 divided by 186.

Next, we calculate the rate of mortality across time periods. To do this, we sum the number of deaths and divide it by the sum of the number of cases across time periods to obtain 0.25. We next calculate the standard deviation for each time period. Finally, upper and lower control limits are calculated. Upper control limit is calculated as the rate across time periods plus 3 times standard deviation for each time period.

Lower control limit is calculated as the rate across time periods minus 3 times standard deviation. For the time period. Negative control limits are set to zero. This plot shows the result of our analysis. The x-axis shows the time periods. The y-axis shows the mortality rate. The red lines without markers show the control limits. Note control limits change because number of cases per time period changes. Sometimes where lots of cases are available, the control limits are tighter. When fewer cases are examined, the control limits are wider apart.

The blue line with the markers shows the observed rate. The interpretation of control charts is simple. Any point outside the limit cannot be due to chance. If a point falls outside of the control limits, then something unusual has occurred in the care process and we need to investigate why the time period is out of control limits. In this data, no points fall outside the limits. Therefore, we conclude that variations in observed rates are similar to historical patterns and there is no time period that should be of concern.

When preparing a report on your analysis, start with the verification of the assumptions. Then include the control chart and its interpretation. For each point that falls outside the control limits, give your hypothesis of what might be going on. P-charts tell us if observed rates are within historical patterns. The key here is that we are comparing each time period to history across time periods.