Introduction to Using Control Charts

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Control Chart Purpose

A control chart is a statistical tool that can help users identify variation and use that knowledge to inform the development of changes for improvement. Control charts provide a method to distinguish between the two types of causes of variation in a measure:

> **Common Causes** - those causes that are inherent in the system over time, affect everyone working in the system, and affect all outcomes of the system. Using your morning commute as an example, it may take between 35-45 minutes to commute to work each morning. It does not take exactly 40 minutes each morning because there is variation in common causes, such as the number of red lights or traffic volume.
>
> **Special Causes** - those causes that are not part of the system all the time or do not affect everyone, but arise because of specific circumstances. For example, it may take you 2 hours to get to work one morning because of a special cause, such as a major accident.

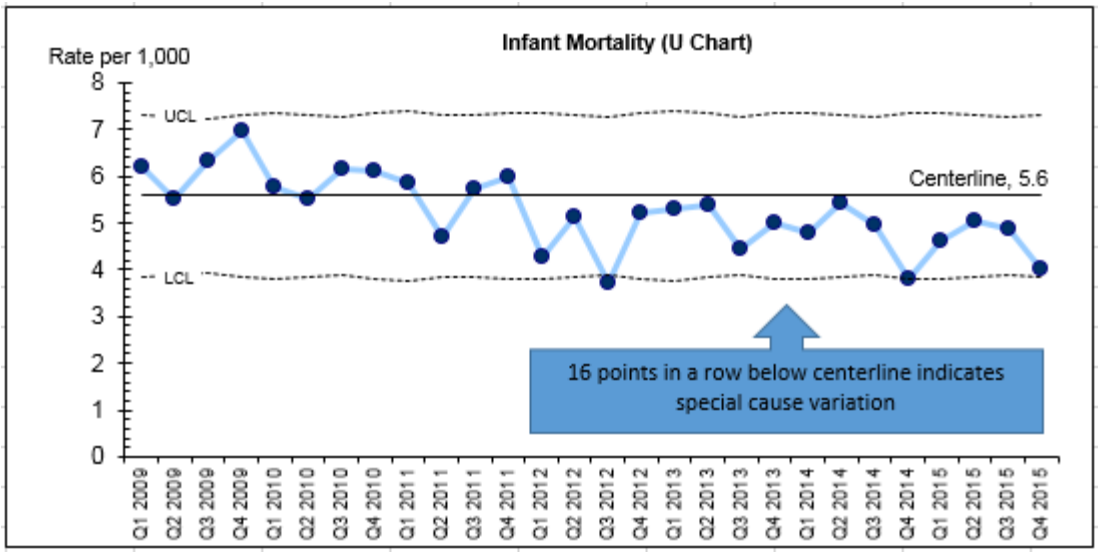
Variation in data is expected and the type of variation that affects your system will inform your course of action for making improvements. A **stable system**, or one that is in a state of statistical control, is a system that has only common causes affecting the outcomes (common cause variation only). A stable system implies that the variation is predictable within statistically established limits, but does not imply that the system is performing well. An **unstable system** is a system with both common and special causes affecting the outcomes. An unstable system does not necessarily mean one with large variation, but suggests that the magnitude of the variation from one time to the next is unpredictable.

Control Chart Components

Control charts include a plot of the data over time with three additional lines:

- The centerline is the average of the individual data points
- The upper (UCL) and lower control limits (LCL) establish the bounds of system performance based on common causes and are set at three sigma from the centerline. The calculation of the sigma value and control limits is based on statistical formulas appropriate for the type of chart being used. There are several control charts available depending on the type of data being analyzed (see references).

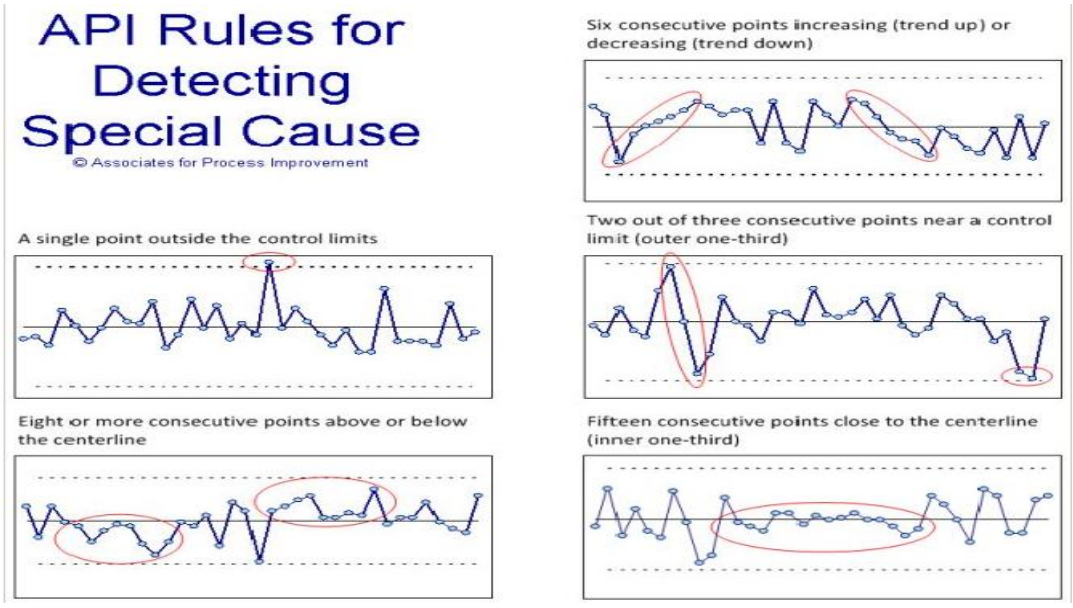
Below is an example of a specific type of control chart called a U chart (chart for rates of count data). This U chart displays the quarterly infant mortality rate for a state from 2009-2015. The centerline is a rate of 5.6 per 1,000 live births. The upper and lower control limit are indicated by dashed lines.



Learning from Control Charts

The control chart helps to inform your action to improve a process or system. In interpreting control charts, ask yourself two questions:

1. **Is the system stable or unstable?** A stable system is a system that has only common cause variation (no special causes identified). An unstable system is a system with both common and special cause variation. There are several guidelines that indicate when a signal of special cause variation has occurred. Below are five rules for identifying special cause on a control charts. If you see one of these rules, it is an indication of an unstable system.



The goal of the chart is not only to detect special cause variation, but also to gain insights into the causal system affecting the measure and take the most informed action. Therefore, control charts should be interpreted by someone who has insight and knowledge about the system that is generating the

measure. Monthly team meetings to review data can help to facilitate discussion on the connection between the data and the changes being tested.

In the Infant Mortality U chart above, there is a signal of special cause variation between Q1 2012-Q4 2015, as indicated by 8 or more consecutive points below the centerline.

2. Based on this knowledge, what type of action makes sense?

Correctly distinguishing between the two types of variation is fundamental to sound decision making. Confusing common cause with special cause variation and vice versa, often leads to actions that increase variation and produce worse outcomes. The rules shown above are designed to minimize the risk of over and underreacting to the patterns of the data.

For a stable system (only common cause variation identified), action should be directed at identifying the important causes of variation common to all the points. Stable systems require design or redesign to create a new system of performance.

For an unstable system (special cause variation identified), action should be taken to learn about the specific circumstances that created these special cause signals. The improvement team should gain an understanding of the changes that led to the special causes and use the new knowledge to improve the system. In improvement work, the team is trying to drive a special cause signal in the direction of improvement as they test changes. In the Infant Mortality U chart above, the improvement team would want to learn more about what programs, initiatives or changes led to better system performance between 2012-2015 and make them a reliable part of their system.

References

This material is adapted from the following references:

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