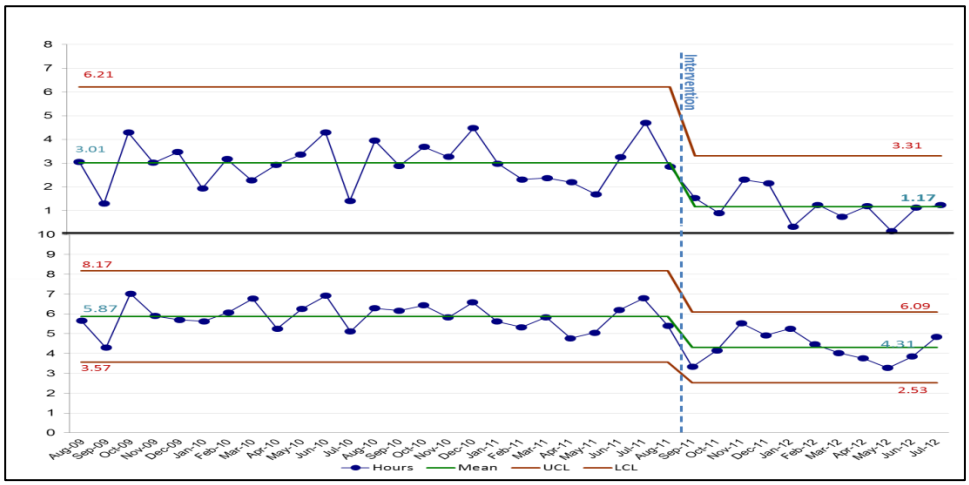
Control Chart

A control chart (also known as a Shewhart Chart) is a graphical display of data plotted over time. It is a simple tool for understanding variation and it has two general uses in an improvement project: as a tool to monitor process stability/control and as an analysis tool. These charts help us understand and visualize the impact of different interventions and tests of change in real-time and over time. Unlike run charts, control charts show if a process is meeting its control limits and how much variation there is from these control limits. Control charts are more sensitive in detecting special cause variation than run charts. The horizontal axis is a time scale (days, weeks, months, quarters, etc.). The vertical axis represents the quality measure being studied (e.g. infection rate, number of patient falls, readmission rate). The mean is calculated and used as the chart's centerline. Upper and lower control limits corresponding to ± 3 sigma limits from the mean provide the basis for accurate analysis. To determine when data signal an improvement, the control limits and chart rules are utilized. Goal lines and annotations of changes and other events can also be added to the control chart. Below is an example of a control chart demonstrating time to treatment.

Figure 2: Average Time from Admission to Antibiotic Treatment



When to Use a Control Chart

- As a **core tool** for improvement projects to
  - Accurately assess whether changes you are making are resulting in true improvement as you make them
- To accurately identify variation and avoid incorrect actions
- To effectively communicate results of your improvement efforts

How Control Charts Are Constructed

1. Obtain a set of ≥15 data points in time sequence and plot them in a line graph.

2. Draw the vertical and horizontal axes, leaving room on all sides to title and label the graph.
3. Label the vertical (Y) axis with the name of the measure (e.g., % of births by C-section, Number of Days to Third Next Available Appointment, etc.).
4. Label the horizontal (X) axis with the unit of time or sequence in which the numbers were collected (e.g., April, May, June, etc., or Quarter 1, Quarter 2, etc.).
5. Determine the scale of the vertical axis. The scale should extend from a number 20% larger than the largest value to a number 20% smaller than the smallest value. Label the axis in equal intervals between these two numbers.
6. Plot the data values in the sequence in which they occurred.
7. Draw lines to connect the points on the graph.
8. Calculate the mean of the plotted numbers and draw the line on the graph.
9. Add control limits
10. Title the chart, and note the goal line and the sample size.
11. Annotate the chart, indicating when key tests of change were initiated.

Control Chart Analysis Rules to Detect Special Cause Variation

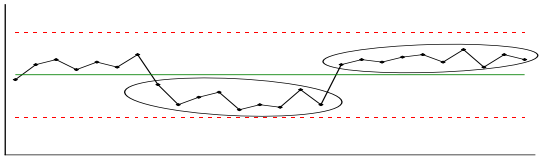
To avoid inaccurate analysis of control charts (and potential tampering/incorrect actions) the control limits and probability-based rules are used to distinguish between common cause and special cause variation. With accurate analysis of your data you are able to determine appropriate actions to achieve the improvement you are striving for.

1. Control Limits

Any data point outside the 3-sigma limit.

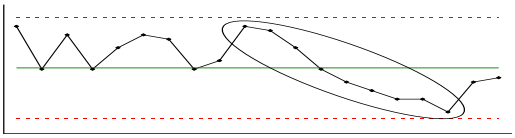
2. Rule 1-Shift

Eight or more consecutive points *either* all above or all below the mean. Values that fall on the mean do not add to nor break a shift. Skip all values that fall on the mean and continue counting.



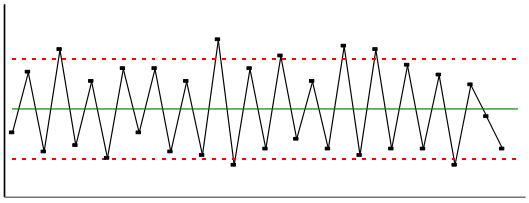
3. Rule 2-Trend

Six or more consecutive points all going up or all going down. If the value of 2 or more consecutive points is the same, only count the 1st point and ignore the repeating values; like values do not make or break a trend.



4. Rule 3-See-Saw Pattern

Fourteen or more points alternating across the mean as illustrated below.



A whiteboard video on control charts and an instructional module-IHI module QI 103, lesson 2-can be viewed at
http://www.ihi.org/education/IHIOpenSchool/resources/Pages/BobLloydWhiteboard.aspx#CC

An on demand presentation on run and control charts can be viewed at
http://www.ihi.org/education/WebTraining/OnDemand/Run_ControlCharts/Pages/default.aspx

Christine M. Walsh-Kelly MD 8-11-15