Deciding which Control Chart to Use

In contrast to the run chart there are numerous ways to construct control charts. The decision of which to use often hinges on the type of data you have collected.
There are two categories of data:

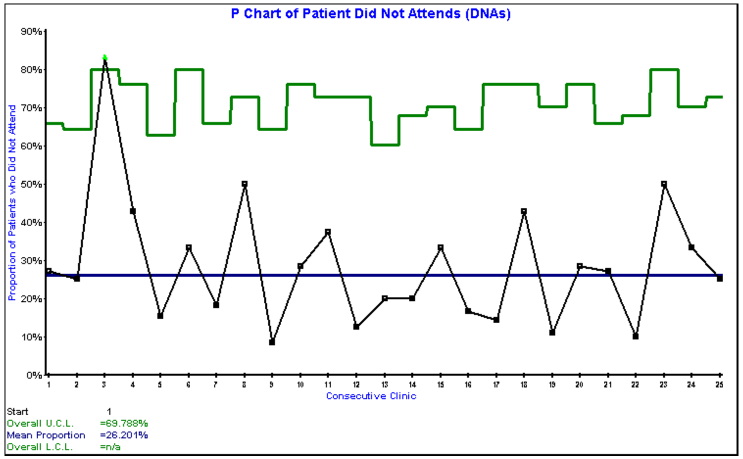
Continuous or Variables Data	Proportion or Attributes Data
This is data that can take on differing values on a continuous scale, over time—e.g. length of stay, total number of discharges, attendances etc	Counts of event that can be aggregated into discrete categories - acceptable vs. non acceptable, infected vs. not infected, late vs. on time, Attendance vs. non attendance

Continuous or Variable Data

At its most simplistic level the appropriate chart to use for continuous data is the **XmR chart**. This chart dose not assume any underlying distribution and control limits are based on the average moving range of point to point variation. There are other types of charts for continuous data where each subgroup or unit of time on the x axis has more than one observation (X bar and S charts and X Bar and R charts).

Discrete or Attributes Data

The **p-chart** (p—Percent or Proportion) is the most easily understood and most often used control chart for attributes data. It plots the percentage of events over time. On this chart the control limits vary with each data point and are calculated based on the denominator.



Once again there are other types of charts that can be used for discrete data, such a the U Chart which is useful for data best measured as a ratio, or a C Chart used for discrete data where the denominator is fairly constant, and the G Chart, which is useful for rare events (time to event analyses).

Resources: Further information about using Control Charts

- Carey (2003) - Improving Healthcare with Control Charts
- Carey & Lloyd (1995) - Measuring Quality Improvement in Healthcare

Statistical Process Control (SPC) Charts

'A one page book'

'Count what is countable, measure what is measurable. What is not measurable, make measurable'."

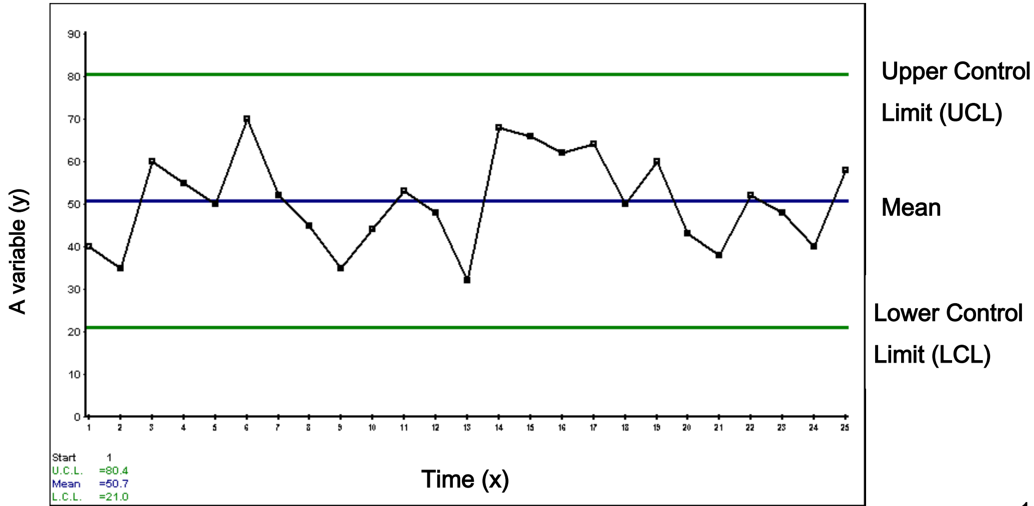
Galileo Galilei

This one page book covers some of the basic theory regarding the use of Control Charts for quality improvement. It builds on the topics summarised in the MCA 'Run Charts' one page book and is best used after those concepts have been practiced and are understood. Run charts are convenient and are easy to construct and understand but they are not as sensitive in detecting special causes as control charts are. The table summarizes some of the differences to consider between Run Charts and SPC Charts.

Run Charts vs. SPC Charts

Run Charts	SPC Charts
Simple & easy to understand and interpret	More complex, not just one type to consider
Easy to create with paper or in Excel	Need a special template or special software
Less sensitive and can miss some special cause signals	More sensitive and powerful tool—control limits provide additional rigor.
No predictive capability	Control limits show the precision and can accurately predict future performance.
Best with 12-25 data points	Best with 12-25 data points

The Anatomy of a Control Chart



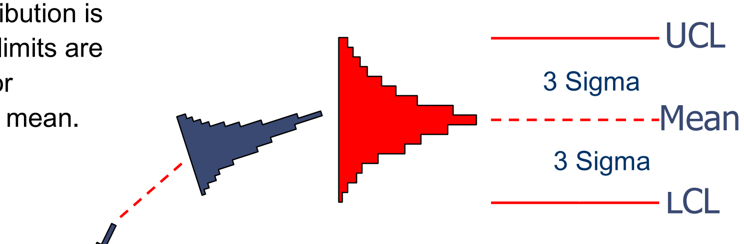
Note that the centre line is the Mean, as opposed to the Median on a Run Chart.

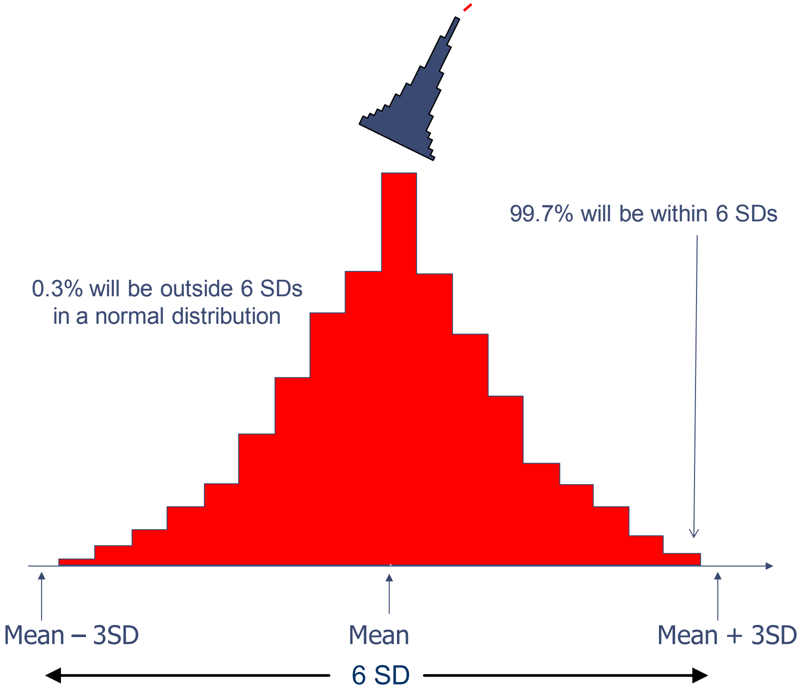
Basic SPC Theory

The statistical principles behind the development of control charts were first developed by Walter Shewhart in the 1920's. Shewhart realized that some variation (Common Cause) was part of the normal (chance) variation of life, and some variation was due to "assignable causes" or statistically significant variations (Special Cause).

In the schematic below, a normal "bell shaped" distribution is displayed. The standard deviation (SD) is a measure of the dispersion of this distribution. SPC charts use an adaptation of this concept in the calculation of control limits.

SPC chart control limits are not calculated using standard deviations because an underlying distribution is not assumed. SPC control limits are approximately +/- 2.67 SD or 3 sigma deviations from the mean.

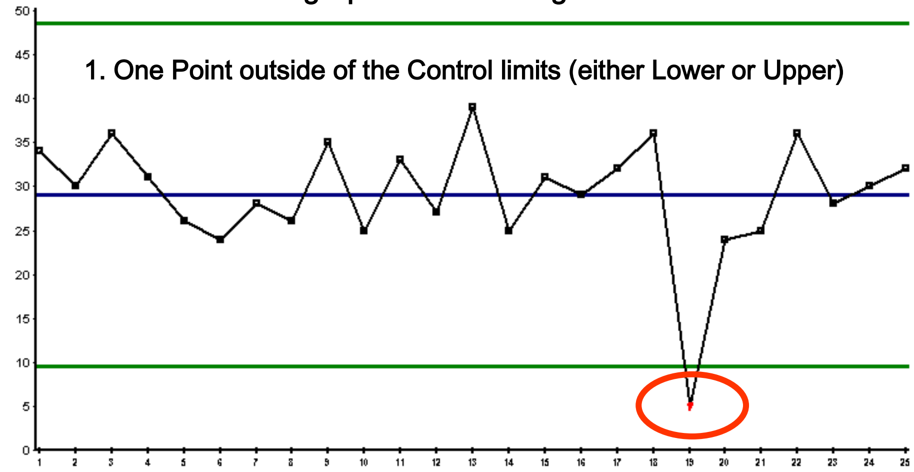


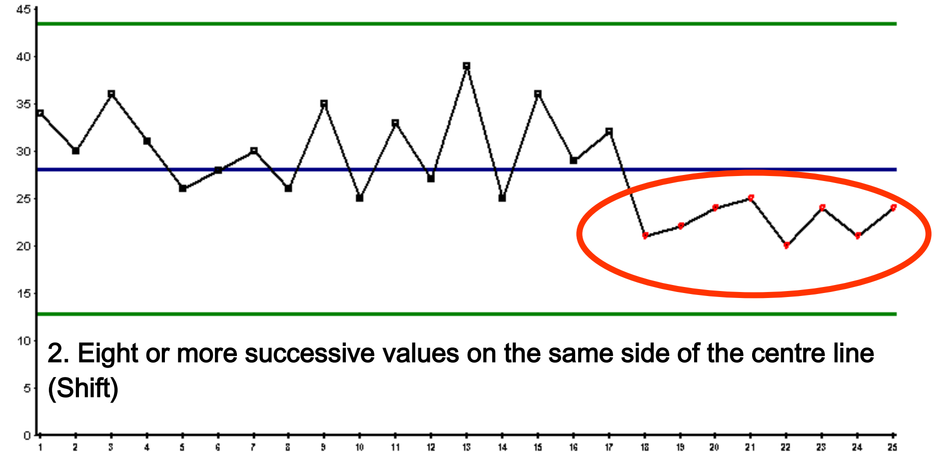


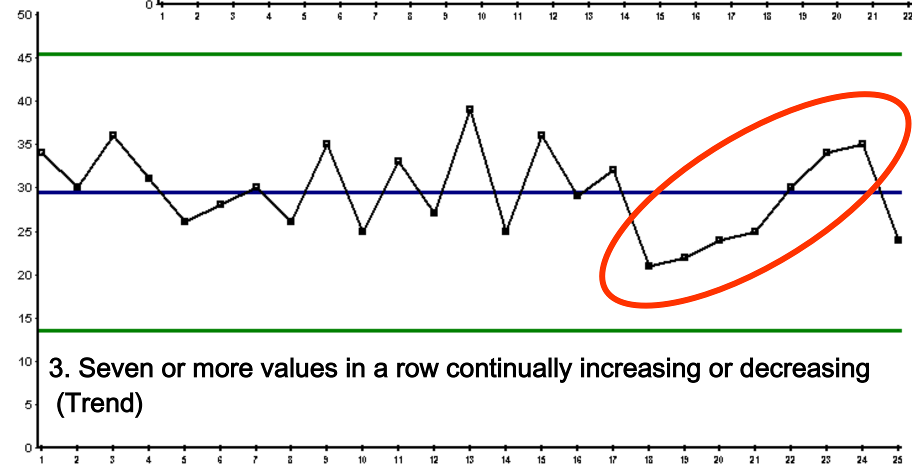
Statistically there is a 0.3% probability of having a data point falling beyond these limits. When a data point does exceed the UCL or LCL this is an indication of a special cause. We can also predict that if nothing in the system changes 99.7% of future points will be within the two control limits

There are different formulae for calculating the control limits for the different types of SPC charts. Most SPC software applications such as WinChart, SPC Excel, QI Macros, Minitab, and others can do control limit calculations automatically.

Basic Tests for Detecting Special Cause Signals on a Control Chart







Note that there are some other more detailed tests for detecting special cause signals but for most healthcare processes the 3 tests above will usually be adequate. (See Carey & Lloyd 1995, or other SPC texts/articles for more detail).