NHS
Central and
North West London
NHS Foundation Trust

Data and Measures Guidelines

CNWL QI Programme

A: Run Charts

13 July 2018

1 Introduction

The purpose of this guide is to provide some simple, practical advice on how we deal with data in run charts.

2 Run Charts

Run charts are one of the most useful tools in quality improvement. They allow us to:

- Monitor the performance of a process over time to detect non-random signals of change.
- Allow us to compare a performance measure before and after implementation of a solution to measure its impact.
- Focuses attention on truly vital changes in the process.
- Assess whether improved performance has been sustained.

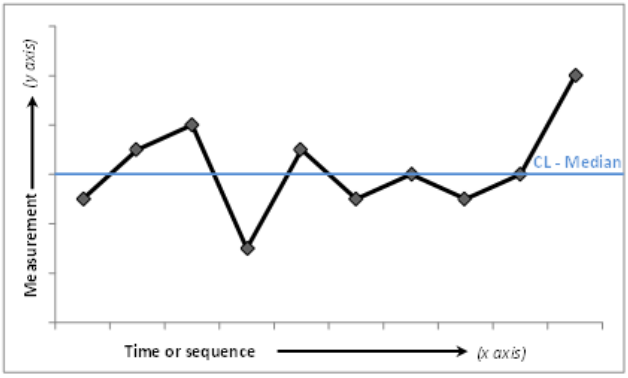
Run charts are a valuable tool at the beginning of a project when you don't have enough data points for a Shewhart Chart.

3 Characteristics of a Run Chart

Steps to create a Run Chart

1. You can create a run chart with 1 data point but need **10 or more data points** to establish a median and apply the run chart rules.
2. Draw a horizontal line (the x-axis), this axis is the time order, label it with the unit e.g. year, quarter etc.
3. Draw a vertical line (the y-axis), and scale it to cover the current data, including sufficient room to accommodate future data points. Label it with the unit of measure.
4. Plot the data on the graph in time order and preferably join adjacent points with a solid line.
5. Calculate the **median** of the first 10-12 data points, the centre line (CL) and draw this on the graph.
6. Annotate your chart to highlight when change ideas are implemented or when notable events occur.

*The **median** is the number in the middle of the data set when the data are reordered from the highest to the lowest value. If the number of observations is even, the median is the average of the two middle values.*



A typical run chart

4 Interpreting a Run Chart

The following definitions are useful before proceeding onto the rules for detecting special variation within run charts and later, control charts.

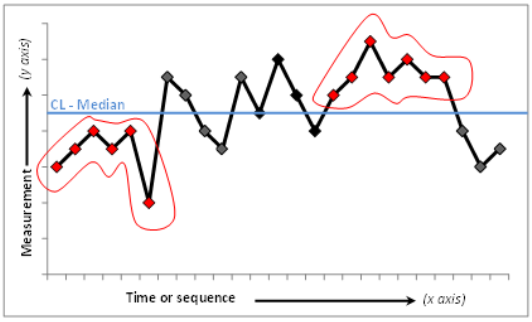
Useful Observations
Those observations that do not fall directly on the centreline are known as “useful observations”. The number of useful observations in a sample is equal to the total number of observations minus the number of observations falling on the centreline.

Run
A sequence of one or more consecutive useful observations on the same side of the centreline. Any observations falling directly on the centreline can be ignored.

There are four rules that can be used to interpret a run chart. Non-random variation can be recognised by looking for:

Rule 1 – Shift

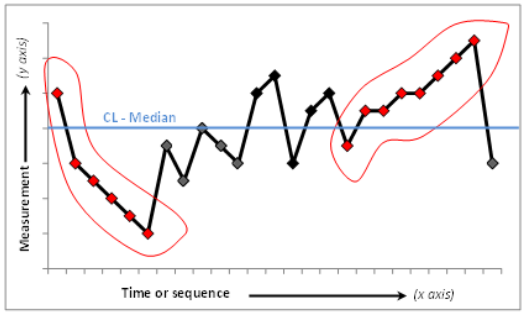
Six or more consecutive points either all above or all below the centre line (CL). Values that fall on the CL do not add to nor break a shift. Skip values that fall on the median and continue counting.



Rule 1 – shift

Rule 2 – Trend

Five or more consecutive points all going up or all going down. If the value of two or more successive points is the same (repeats), ignore the like points when counting.



Rule 2 – trend

Rule 3 – Too many or too few runs

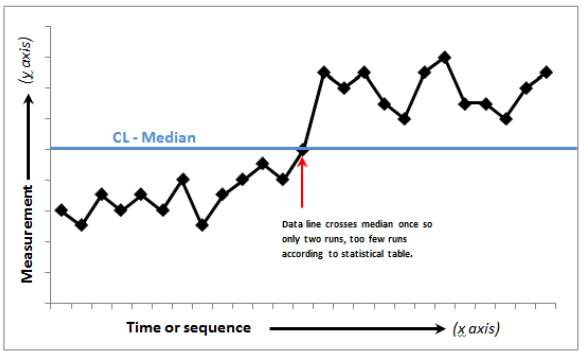
A non-random pattern is signalled by too few or too many runs, or crossings of the median

Rule 4 – An astronomical data point

This is a data point that is clearly different from all others. This is a judgement call.

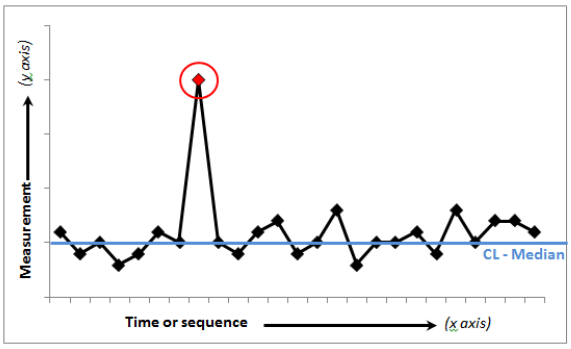
line. If there are too many or too few runs, this is a sign of non-random variation. To see what an appropriate number of runs for a given number of data sets, refer to statistical table **in Appendix 1.** An easy way to count the number of runs is to count the number of times the line connecting all the data points crosses the median and add one. If the number of runs you have are:

- Within the range outlined in the table, then you have a random pattern.
- Outside the range outline in the table, then you have a non-random pattern or signal of change.



Rule 3 – Too many or too few runs

Different people looking at the same graph would be expected to recognise the same data point as astronomical.



Rule 4 – An astronomical data point

5 Setting Medians

Text books and training courses often refer to a data series with a median applied across the whole data set. In quality improvement projects within the parameters set out earlier, we recommend the use of a baseline median, from which variation is then detected.

Baseline medians

Where enough data are available before any improvement activity, we would generally use at least **10 or more data points**. The decision is based on having enough data to gauge probability.

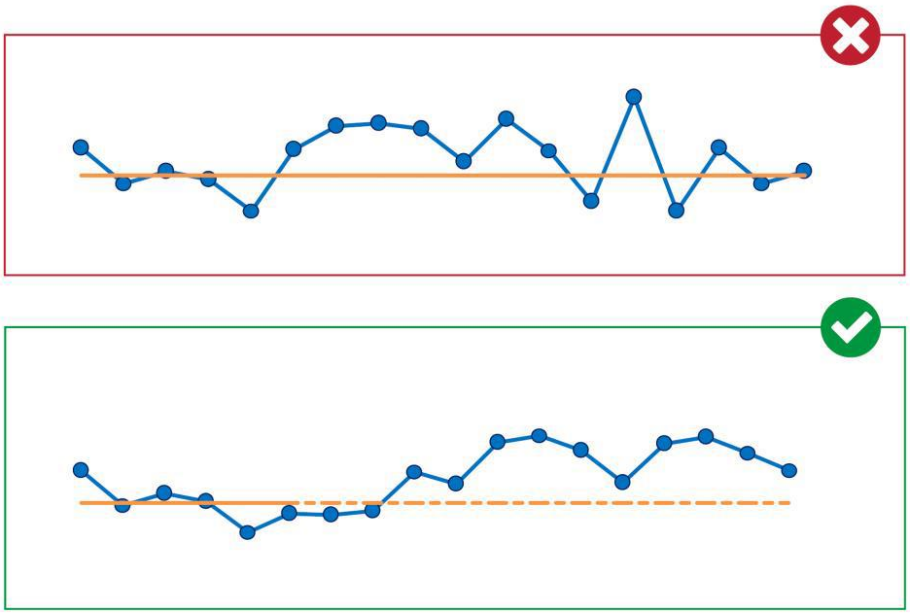
Where no previous data is available, as a starting point follow the guidance below:

- Collect data as frequently as possible (daily if possible) to learn quicker about the process and get to a Shewhart Chart faster
- Daily or weekly data can be more useful than monthly.
- Never recommend longer than monthly

Ideally, baselines should only be calculated based on a set of data points that do not show any non-random variation. If a shift, trend or run count rule is broken within the baseline median period, the baseline should be considered temporary until no signals are detected.

Extended baselines

A baseline median should be set for the defined periods and extended into the rest of the data set. Not doing this can affect the ability of the run chart to detect change. This should be visually apparent by changing the appearance of the extended median, for example, by using a dotted line.



6 Rephasing Run Charts

What is rephasing?

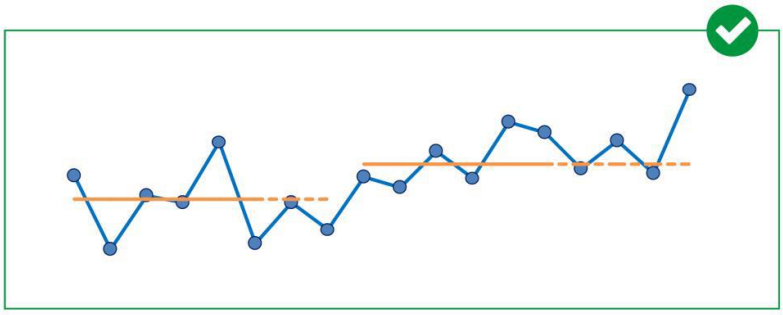
Rephasing is when data have shown a change in performance to the degree that a new median is required to be created to describe the new level of performance. Future variation is detected from this new baseline.

When to rephase

The decision to rephase is a combination of having a rule showing a signal and knowing a known change to the process occurred.

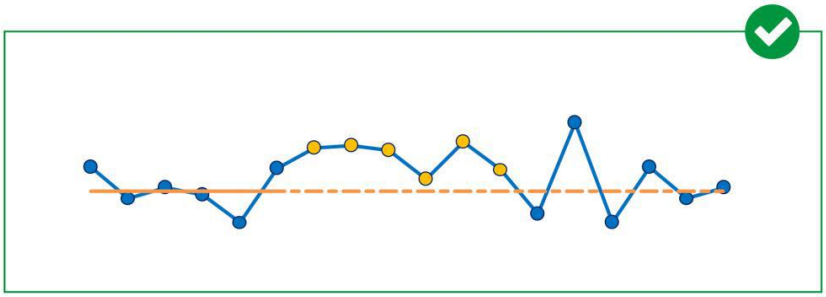
The most likely reason to rephase is when a shift is detected. We would not advise rephasing as soon as a shift is seen; the same 10 data points or more rule applies for a new baseline median. Until it has been maintained, the shift should be highlighted in any visualisation.

When the shift has been maintained a new median can be calculated. In general, the new median can be based on the same number of data points as the baseline median.



For an outcome measure or weekly process measure, the recalculated median will initially be based on **10 or more data points** and would be considered temporary. The median would then be recalculated to include new data points as they become available and, after **10 or more data points**, the median can be fixed and the level of change can be assessed. The new median should be extended as per the original baseline median, as this is then the point from which further variation is detected.

Where a shift does not appear to be maintained, it is recommended that the median is not changed but that the shift is visually highlighted in some way. For example, change the colour of the points.



Once you achieve 12-20 data points on your run chart it is useful to change your chart at this point to a control (Shewhart) chart

Consistency of definition

Within the scope of a quality improvement project, data definitions are very important in order to truly understand the changes in a system. Although a small amount of variation can be expected, knowingly moving from one definition to another renders analysis using run chart rules impossible. This sort of change is sometimes necessary and can be a positive change, but the visualisation of this needs to be handled carefully.

7 Run Chart Tool

The Trust has decided to use the following tools for run charts.

Option 1:
If you are running a QI project please input your data into Life QI and this will create your run chart for you https://uk.lifeqisystem.com/login/ . If you have added your QI project onto **LifeQI** the system will generate your run chart for you.

Option 2:
If you are not running a QI project (and therefore not using LifeQI) but want to display your time series data using an run chart, please use QI Macros. https://www.qimacros.com This will need to be purchased locally. If you need help on how to do this and / or to use the tool, please contact cnw-tr.improvementsupport@nhs.net

Reference

Data and Measurement: How we put run chart theory into practice for improvement projects. Healthcare Improvement Scotland. June 2017.

Healthcare Data Guide: Learning from Data for Improvement, Provost and Murray. 2011.

Appendix 1

Runs Rule Guidance

Total no. of data points on run chart not falling on median	Lower limit for no. of runs *(< than this is "too few")*	Upper limit for no. of runs *(>than this is "too many")*
10	3	9
11	3	10
12	3	11
13	4	11
14	4	12
15	5	12
16	5	13
17	5	13
18	6	14
19	6	15
20	6	16
21	7	16
22	7	17
23	7	17
24	8	18
25	8	18
26	9	19
27	10	19
28	10	20
29	10	20
30	11	21
31	11	22
32	11	23
33	12	23
34	12	24
35	12	24

Total no. of data points on run chart not falling on median	Lower limit for no. of runs *(< than this is "too few")*	Upper limit for no. of runs *(>than this is "too many")*
36	13	25
37	13	25
38	14	26
39	14	26
40	15	27
41	15	27
42	16	28
43	16	28
44	17	29
45	17	30
46	17	31
47	18	31
48	18	32
49	19	32
50	19	33
51	20	33
52	20	34
53	21	34
54	21	35
55	22	35
56	22	36
57	23	36
58	23	37
59	24	38
60	24	38

Table 1. Runs Rule guidances – Table for checking Too many or Two few Runs on a Run chart.