

*Data and Measurement:*  
How we put run chart  
theory into practice for  
improvement projects



A run chart is a simple analytical tool that helps us understand changes in data over time. We describe here, within parameters typical of a quality improvement project, how Healthcare Improvement Scotland constructs, uses and interprets run charts to understand change in a system or process.

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

For an introduction to run charts and rules for interpretation, we recommend the paper published by Perla, Provost and Murray, *The Run Chart: a Simple Analytical Tool for Learning from Variation in Healthcare Processes*<sup>1</sup>.

Although, their paper provides clear guidance on how to construct a basic run chart and detect a signal of non-random variation, the next steps you would take in your analysis are not necessarily covered. This is largely due to the subjectivity of some of these decisions.

We hope this guide on our approach will help with your journey of data interpretation. Provost & Murray also go into more detail in *The Health Care Data Guide: Learning from Data for Improvement*<sup>2</sup>.

Data sets for quality improvement projects take many shapes and sizes; we cannot provide generic guidance that will suit

every eventuality, but for the purpose of this guide, we will work within a basic set of data criteria:

- data are displayed monthly at a minimum, weekly process data are preferable
- if using a sample, sample size is 20 or more for each data point, and
- time-between run charts are used when more than half the data points are at the extreme values on the scale (for example 0 or 100 on a percentage scale).

We think that the approach taken will suit most applications, but if your data set falls out with the parameters above then some more thought may be required.

Internally, the Data & Measurement Advisors in the Data Measurement & Business Intelligence Team can provide this support. However, if you are working outside Healthcare Improvement Scotland, you are also welcome to access this support (see end of guide for contact details).

# Interpreting a run chart

There are four common rules for highlighting non-random variation in run charts: a shift, a trend, too many or too few runs, and astronomical points. There are slightly different published definitions for these, but in Healthcare Improvement Scotland we use the following definitions taken from Perla et al 2010<sup>1</sup>.

## Shift

A shift is six or more consecutive points all above or all below the median. Values that fall on the median do not add to, nor do they break, a shift. Skip all values that fall on the median and continue counting.

## Trend

A trend is five or more consecutive points all going up or all going down. If the value of two or more consecutive points is the same, only count the first point and ignore the repeating values; like values do not make or break a trend.

## Too many or too few runs

A run is a series of points on one side of the median. A reference table (see Perla et al 2010<sup>1</sup>) is used to determine if there are too many or too few runs which can suggest non-random variation.

## Astronomical points

An astronomical point is one which is obviously very different from the other values. This is not a mathematical assessment but rather one of subject matter knowledge and, therefore, must be made in partnership with someone who is working directly on the measure of interest and is aware of what may cause or influence such a value.

# 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

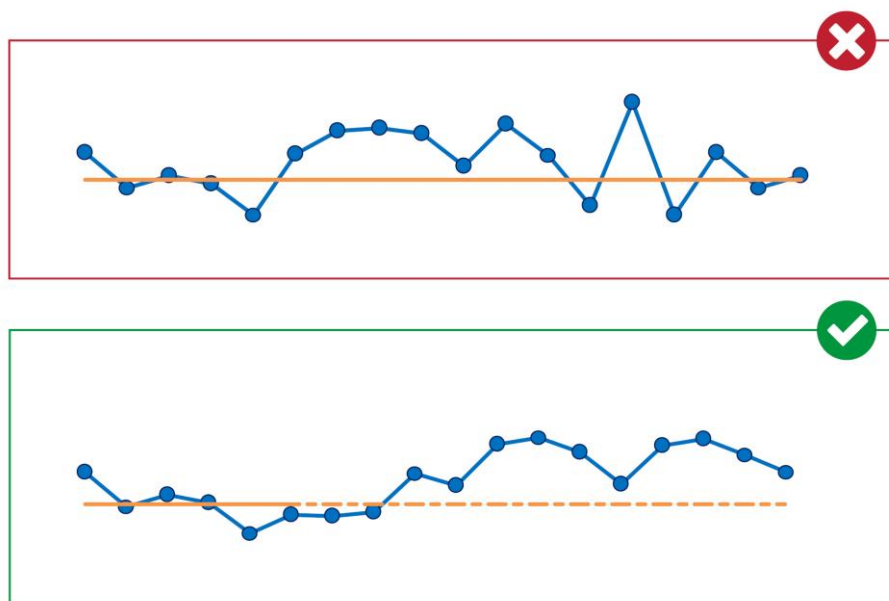
Where enough data are available before any improvement activity, we would generally use at least 12 data points. Subject matter knowledge is required to make good decisions in this area. Where no previous data are available, as a starting point we follow the guidance below:

- monthly outcome measure – use the first 12 data points
- weekly process measure – use the first 10 data points (remember to keep sample size at around 20 for percentages), and
- monthly process measure – use the first six data points.

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.

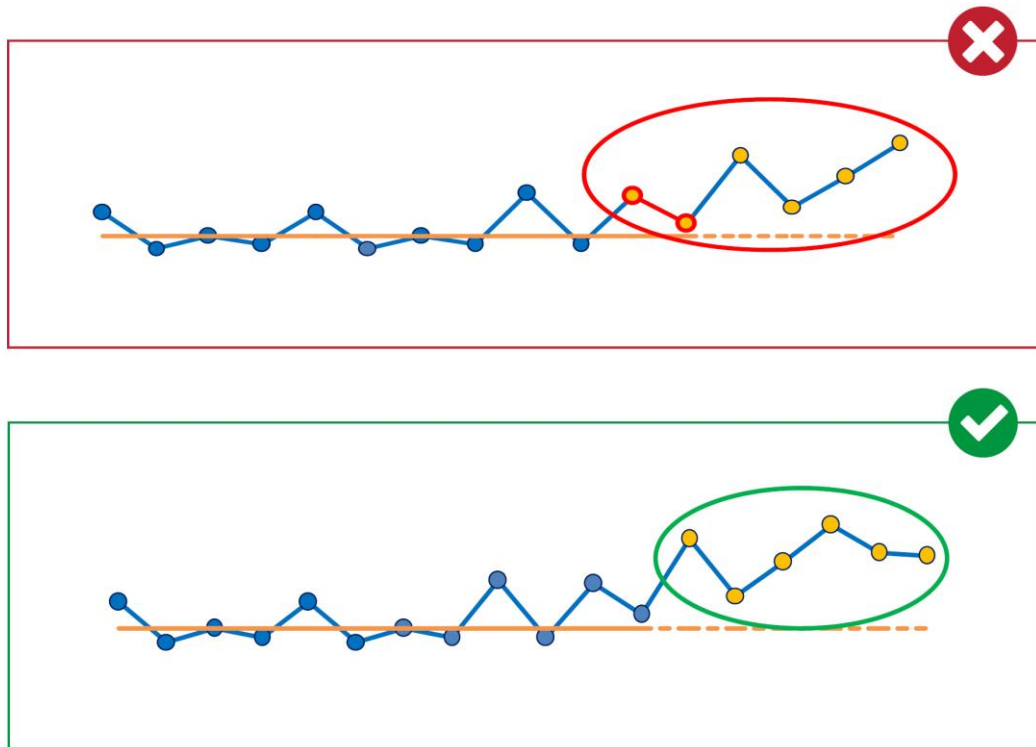
## Extended baselines

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.



## Baselines and applying rules

We do not include data points that contribute to baseline median in a shift.



## Rephasing run charts

### What is rephasing?

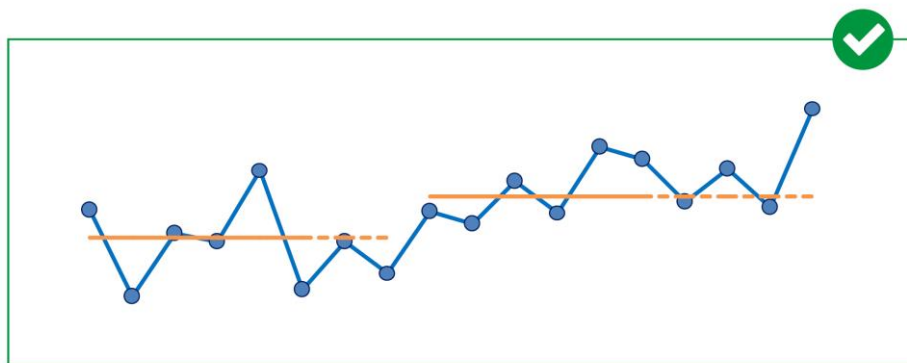
Rephasing is when data have shown a change in performance to the degree that a new median is required to be created to describe the new level of performance. Future variation is detected from this new baseline.

### When to rephase

The decision about when to rephase is something that it is difficult to define based on the data alone, but as a rule we use the following guidance.

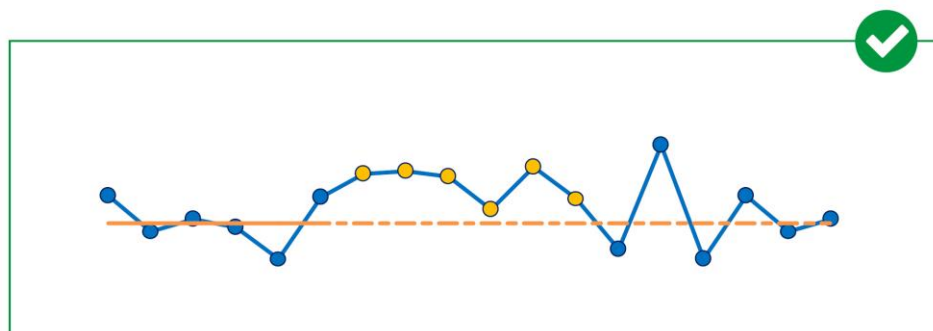
The most likely reason to rephase is when a shift is detected. We would not advise rephasing as soon as a shift is seen; we would wait for a further three data points in the shift to be sure it has been maintained. Until it has been maintained, the shift should be highlighted in any visualisation.

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 nine data points and would be considered temporary. The median would then be recalculated to include new data points as they become available and, after twelve 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.



If no movement is noted from the median over the course of 24 data points or more, we would consider if the baseline median should be extended to include the "new" data.

### Magnitude of change

The percentage change in medians can be used to quantify the magnitude of change in the measure.

## 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.



## Help?

This is a simple guide on how Healthcare Improvement Scotland tries to take a standard approach to the visualisation and analysis of run charts. We hope this will be a useful reference for other improvement activity as we think it will cover a wide range of scenarios, although it is not intended to be exhaustive or definitive.

If you find your data set does not fit within any of the parameters outlined or you suspect that your analysis is not detecting change, is detecting a false signal, or you have other queries about run charts and their application in quality improvement projects then you are welcome to get in touch to discuss this. You can contact us by dropping in to see us in the Data, Measurement & Business Intelligence Team on the 2<sup>nd</sup> floor in Gyle Square, Edinburgh or you can email us at [his.dmbiteam@nhs.scot](mailto:his.dmbiteam@nhs.scot)

## References

1. Perla RJ, Provost LP, Murray SK. The run chart: a simple analytical tool for learning from variation in healthcare processes. *BMJ Qual Saf.* 2011;20(1): 46-51.
2. Provost LP, Murray SK. *The Health Care Data Guide: Learning from Data for Improvement.* Hoboken, New Jersey: John Wiley & Sons; 2011.



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The Healthcare Environment Inspectorate, Improvement Hub, Scottish Health Council, Scottish Health Technologies Group, Scottish Intercollegiate Guidelines Network (SIGN) and Scottish Medicines Consortium are part of our organisation.