Online library of Quality, Service Improvement and Redesign tools

# Run charts

NHS England and NHS Improvement

# Run charts

## What is it?

Run charts are displays of time-series data shown in graph form and are very useful tools for improvement work – particularly in terms of how you understand and communicate variation in a process. Being able to analyse and understand current system variation is key to being able to make changes that improve processes and systems.

## When to use it?

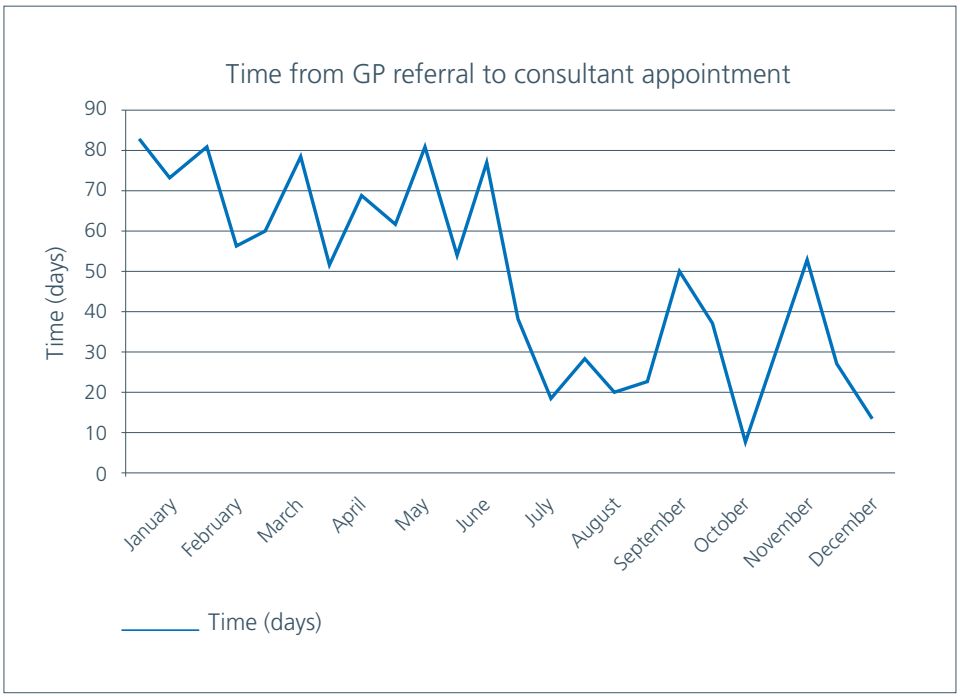
You can use run charts as a simple way of helping to analyse information. Run charts are a powerful tool for detecting special cause (non-random) variation (although **statistical process control (SPC)** charts are even more sensitive to detecting special causes).

Being able to analyse and understand variation in your system is key to making changes that will improve your processes and systems.

## How to use it?

Run charts use the middle value (median) and so apply rules for detecting special cause variation that rely on addressing whether data points are above or below the middle value. The relative distance from the median is not taken into account.

**Figure 1: An example of a run chart**




Looking at the example above, you can see that if only two points are considered (eg February and September), you could be mistaken for thinking that the cycle time – in this case the time between GP referral and a patient being seen by a consultant – has hardly changed.

By adding more data points to the chart, however, we can see that the cycle time is variable. From June onwards (when the changes were implemented), there is still variation in the system but the implemented change has improved the system overall.

This example shows one of the major advantages of using run charts – they preserve the time order of the data unlike statistical significance tests, which generally compare aggregated sets of data.

Variation between demand and capacity is one of the main reasons why queues occur in the NHS because every time demand exceeds capacity a queue is formed, which we see as a waiting list or backlog.

Variation is a part of everyday life and so when we are looking at improvement data, it is easy to over or under-react to a single or most recent data point and intervene in some way with the process.

While every process displays variation **some processes display controlled variation (common cause)** characterised by:

- a stable, consistent pattern of variation
- constant causes/'chance'.

**Others display uncontrolled (special cause) variation characterised by:**

- pattern changes over time
- special cause variation/'assignable' cause.

How you approach improvement in a process depends on which sort of variation is present:

- Common-cause variation is normal, random variation. Respond to this by reducing the variation – a process with limited or no variation will deliver standard results.
- Special-cause variation is shown when changes in the pattern of data can be assigned to a specific cause ie performance is unpredictable. The cause may or may not be beneficial or intentional. Respond to this by understanding what was the cause, if it was beneficial you may want to do more of it, if it was not beneficial, you may want to avoid it happening again.

It is important to understand the reason for special cause variation and not to react unnecessarily to one-off changes in the behaviour of a process. Run charts are a powerful tool for detecting special cause (non-random) variation. They are simple to do and relatively straightforward to interpret – analysing a run chart may be as simple as looking at it if you follow these steps:

1. Plot data in time order – the horizontal axis is most often a time scale (eg days, weeks) and the vertical axis represents the quality indicator you are interested in (eg number of admissions, readmission rate, infection rate).
2. Calculate and display the median as a line.

**Why do we use the median as the centre line in run charts?**

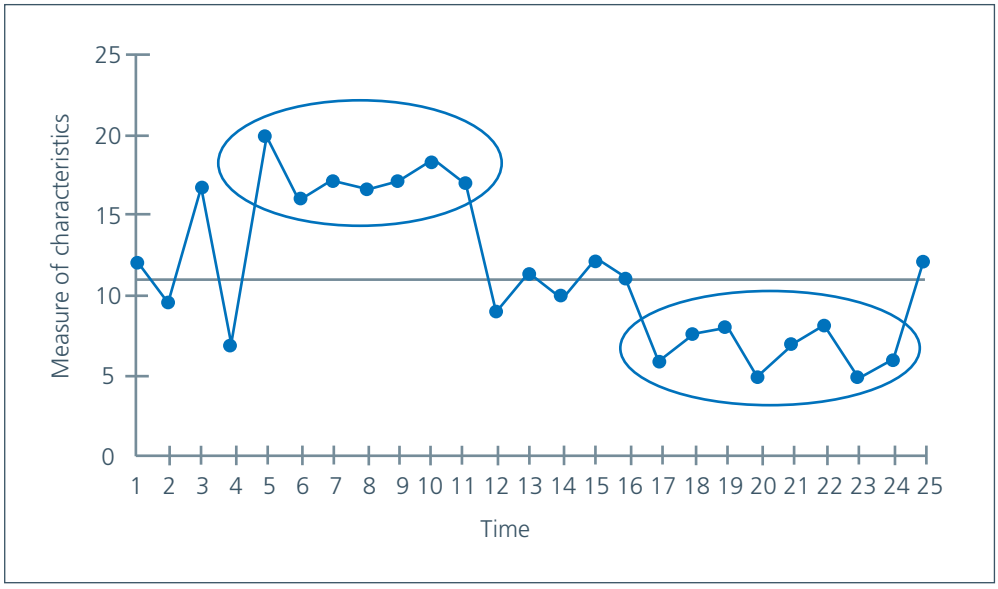
- **The median is the point at which half of the data points will be above and half will be below the centre line.**
- **The median isn't influenced by extreme values in the data.**

3. Analyse the chart by studying how values fall around the median. There are some simple probability-based rules you can use to analyse a run chart objectively to look for evidence of special cause variation. If one (or more) of the rules is met in your run chart, it is a sign that there is non-random variation.

### Rule one: Shift

Seven or more consecutive points either all above or all below the median. Data points that fall on the median do not count ie they do not add to or break a shift so when counting data points, don't count any that fall on the median and continue counting.

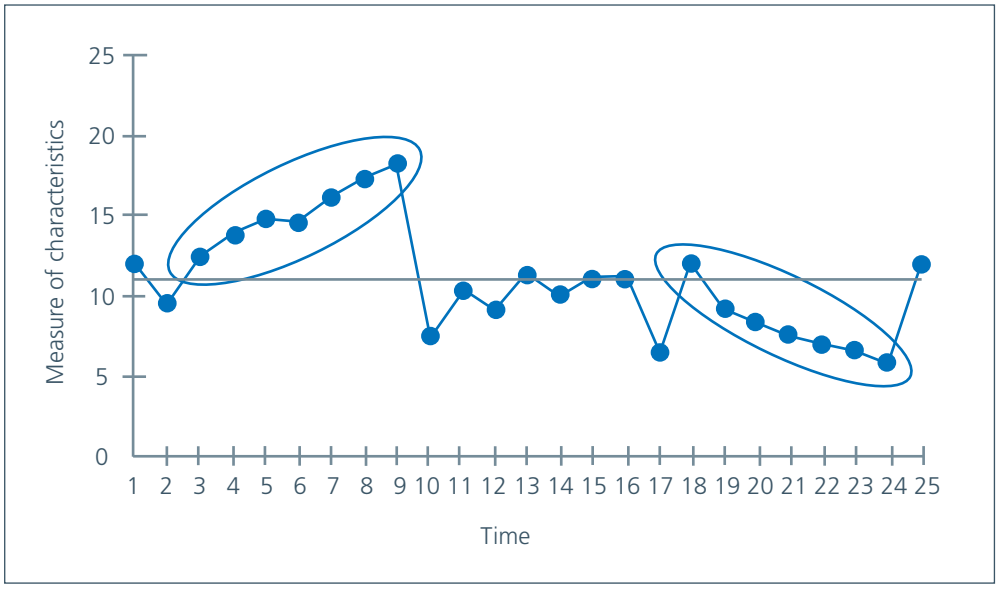
**Figure 2: Shift run chart**




### Rule two: Trend

Seven 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 as they do not make or break a trend.

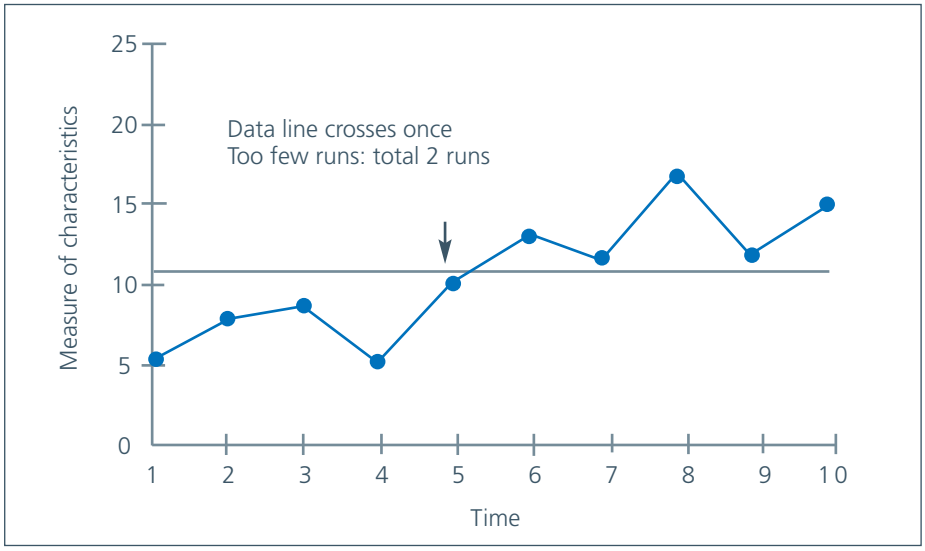
**Figure 3: Trend run chart**



### Rule three: Runs

Special cause variation can be indicated by too many or too few runs. A run is a series of points in a row on one side of the median. If only random variation is influencing the process being measured, then we would expect some regularity in terms of data points falling above and below the line. An easy way to count the number of runs is to count the number of times the line connecting the data points crosses the median and add one to that number.

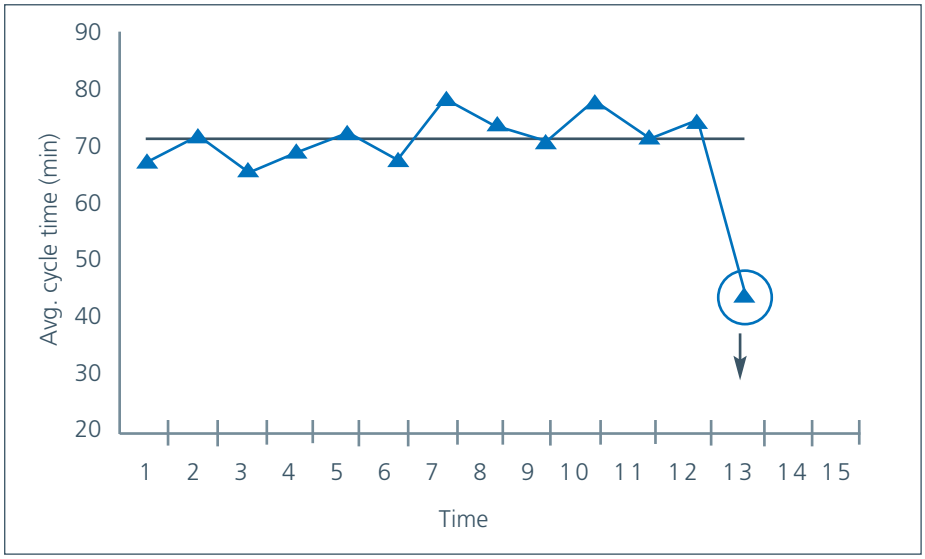
**Figure 4: Run points run chart**




### Rule four: Astronomical point

Whilst the other three rules are probability-based, rule four is subjective. It is reliant upon the visual display of the data. An astronomical data point is one that is obviously different from the rest of the points and it is obvious to someone looking at the runchart. Don't confuse them with the highest and lowest data points – every chart has those.

**Figure 5: Astronomical point run chart**



## What next?

To ensure that run charts are interpreted correctly, keep a record of external factors and events that may influence the outcomes – for example, when a clinician is absent due to illness.