NHS
Central and
North West London
NHS Foundation Trust

Data and Measures Guidelines
CNWL QI Programme

B: Statistical Process Control (SPC) Charts

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1 Introduction

The purpose of this guide is to provide some simple, practical advice on how we deal with data in Statistical Process Control (SPC) charts.

2 SPC Charts

Control charts are commonly referred to as Shewhart charts, named after Walter Shewhart who did early work in industry to develop this method. The control (Shewhart) chart is a statistical tool used to distinguish between variation in a measure due to common causes and special causes.

Run charts are a powerful tool for detecting non-random variation but they are not sensitive in detecting special causes. Hence they are used in the early stages of an improvement project. Once more data is available, control charts are much preferred.

3 Types of Variation

The two types of variation that we are interested in are 'common cause' and 'special cause' variation.

Common Cause
All processes have random variation - known as 'common cause variation'. A process is said to be 'in control' if it exhibits only common cause variation i.e. the process is completely stable and predictable, with any variation due to regular, natural or ordinary causes. Common cause doesn't necessarily mean you like it or it is good performance, only that it is predictable variation and a result of the process you have.

Special Cause
Special cause is also called attributable cause. There is a reason for it and it's different.
If you make an improvement and have for example a shift, that's and improvement and planned.
If you have a special cause, you need to decide what happened and try to stop it if it is undesirable or sustain it if it is desirable.

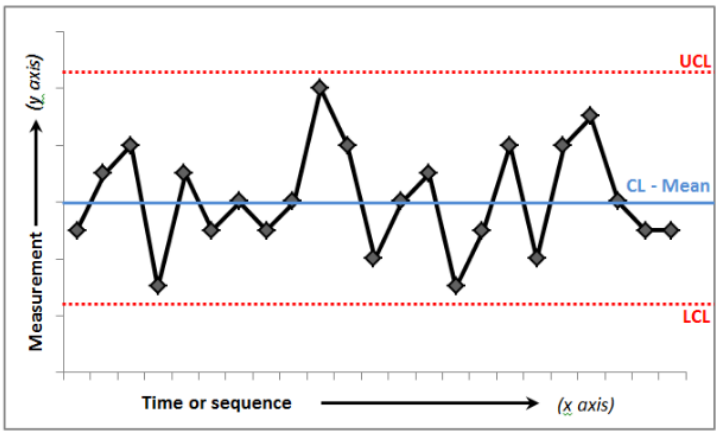
4 Characteristics of a Control chart

- On the X axis you have data in some sort of chronological order e.g. Jan, Feb, Mar
- On the Y axis you have the measure of interest e.g. %, count
- Once the data points are connected you put a centre line (CL) between the graph. For a control chart the CL is called the **Mean**.

*The **mean** is calculated by taking all the values in the baseline and dividing by the number of values (also known as the average).*

- Control charts also contain control limits, based on the data and the result of a statistical calculation. You have an upper control limit (UCL) and a lower control limit (LCL).
- The control limits define the boundaries of expected common cause (random) variation around the mean.
- The upper and lower control limits are classically known as sigma limits.
- Another variation of a control chart to a run chart is the number of data points required. Typically a control chart needs around **12 data points (20 points are required for an I-**

Chart) whereas a run chart can be made using a minimum of **12 data points**. The reason being is the mean is more sensitive to point to point variation.



An example of a typical control chart

5 Types of SPC Charts

There are many different types of data available, and the correct chart to use depends on the type of data being collected.

Types of Data

Continuous data (this is the preferred type of data)
Occupy any value within a range. Typically a measurement of some kind, they are unrestrained by "categories", and can be infinite in range. Examples of continuous data would be measurements of height, weight or length; monetary values and anything which could be considered workload or throughput.

Attribute data
Observations where each possible observation is distinct from one another. It can be categorical e.g. number of red balloons handed out at a fair; or numeric, typically count data e.g. the number of falls in a care home each month; or binomial data e.g. how many red balloons are handed out each hour. Typically, when putting a binomial process into an SPC chart, the data should be presented as a proportion of a success, or a proportion of failures.

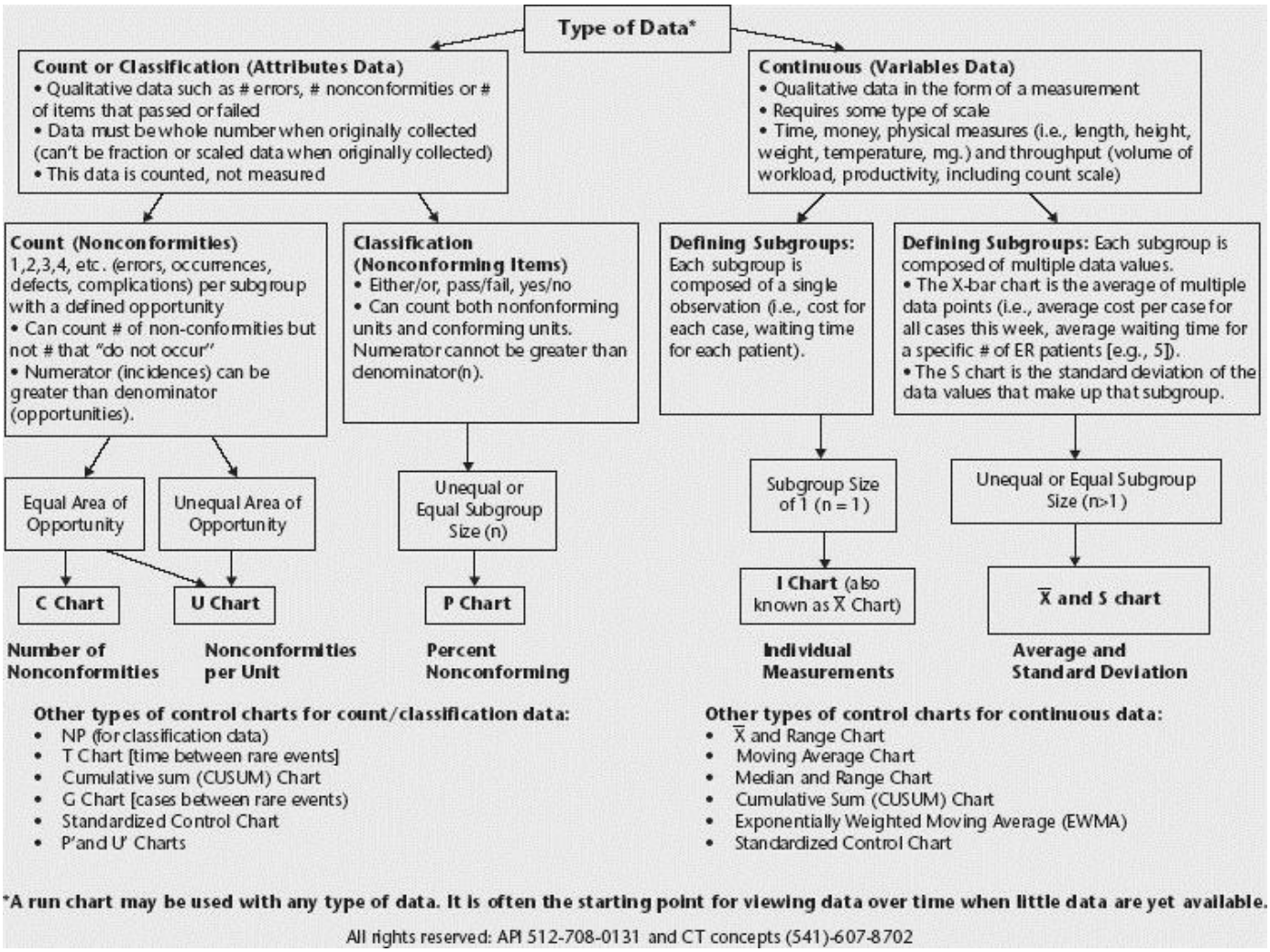
A list of chart types and a brief summary of the types of data they serve is found in Table 1

Table 1: Types of Shewhart Control Chart.

Chart Name	Appropriate For
XmR / I Chart	Continuous data, where each data point is an individual measurement and not an aggregate or average of multiple data points
Xbar & S Charts	Continuous data, where each data point is an average of multiple data points
P Chart	Discrete data. Data should be a proportion/percentage of successes/failures
C Chart	Count data, where the “area of opportunity” is equal for each data point
U Chart	Count data, where the “area of opportunity” is unequal for each data point
T Chart	For rare events data, recorded as time between unlikely events (continuous).
G Chart	For rare events data, recorded as the number of events between unlikely events (discrete).

The flow chart (Figure 2) below illustrates the decision making process for choosing the correct chart type.

Figure 2



7 SPC Chart Tool

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

Option 1:
If you are running a QI project please input your data into Life QI and this will create your SPC chart for you https://uk.lifeqisystem.com/login/ . If you have added your QI project onto **LifeQI** the system will generate your SPC chart for you. You simply need to choose the correct chart for your measure (see **Table 1**), guidance on this is also found on Life QI.

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 SPC 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

Steps to create a Control Chart

1. First, select the most appropriate control chart for your data, which is dependent on the properties of you data. Use the flow chart in Figure 2 and Table 1 to help with this.
2. Proceed as for the run chart, this time using the mean as the centreline.
3. Calculate the upper and lower control (these will be created automatically if you use the tools)
4. Annotate your chart to highlight when change ideas are implemented or when notable events occur.

8 SPC Chart Rules

In order to interpret data from a control chart correctly, a set of consistent rules must be applied to highlight any special cause variation. These rules highlight data points which may be of interest in order to prompt the user of the data to investigate further.

Table 2 contains standard **Shewhart Control Chart Rules** for identifying special cause variation agreed for Improvement Programmes in CNWL.

Table 2: Shewhart Control Chart Rules.

Rule	Description
Outlier	Data point(s) exceeding the upper or lower control limits (at 3 sigma limits).
Shift	A run of 8 or more consecutive data points above or below the centre line.
Trend	A run of 6 or more consecutively increasing or decreasing data points. An observation that is the same as the preceding value does not count towards a trend.
Outer One – Third	Two out of three consecutive data points which sit close to one of the warning or control limits (outer one-third of chart).
Inner One - Third	15 or more consecutive data points that lie close to the centreline (inner one-third of chart)

These are standard rules which should be applied to all Shewhart Charts.

References

Statistical Process Control: Monitoring Quality in Healthcare - Tutorial Guide. National Health Scotland.

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