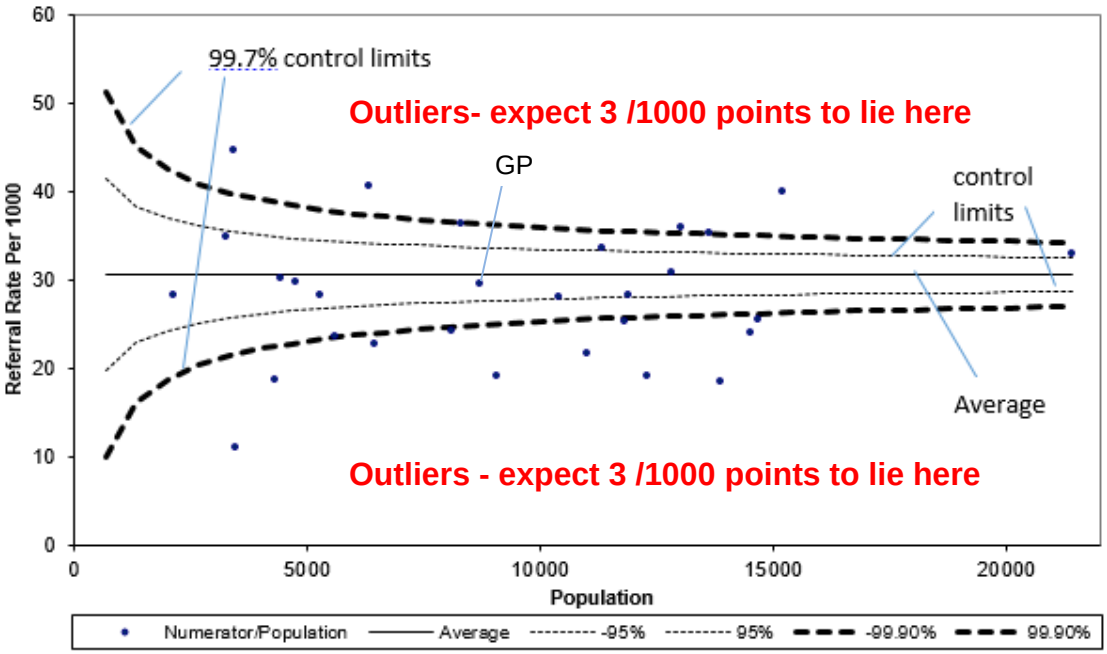
NHS
Tower Hamlets
Clinical Commissioning Group

How to Read Funnel Plots

1. What are funnel plots?

- Graphs that display variation within a system
- Identifies outliers
- Commonly used in healthcare for comparing the outcomes of organisations/providers
- Plots an outcome against its relevant area of opportunity (instances where that event could have occurred)
    - E.g. referral rate vs list size

Example- Referral Rate- Funnel Plot



*Points outside the funnel are considered outliers

Key Components of a Funnel Plot

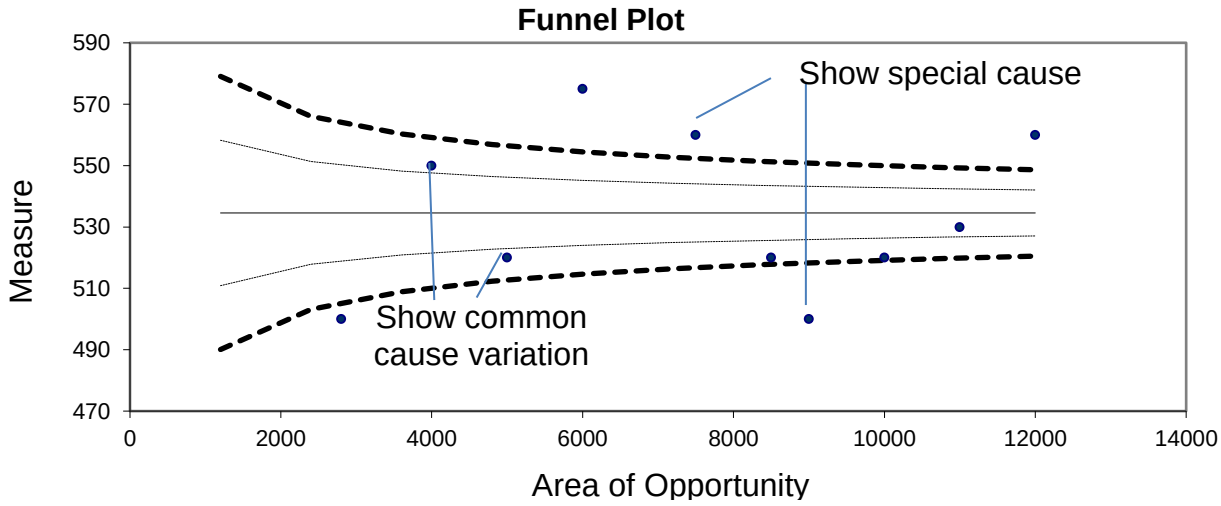
- Each blue dot represents a GP practice
- Vertical axis plots the measure either as whole numbers or as a rate per 1000
    - E.g. the referral rate per 1000 patients
    - The higher up the axis the blue dot is, the higher the practices rate of referrals per 1000 patients
- Horizontal axis measures the area of opportunity e.g. list size so the practices can be easily compared

- The bigger practices are on the right and the smaller practices are on the left
- Average line measures the overall rate per 1000 for all GP practices combined e.g. 30 referrals per 1000 practice population
- Control Limits
  - Statistically calculated limits that show that where the points should lie in a controlled system based on probability
  - Any observation plotted within the funnel limits would be expected[1]
  - Overall help us interpret the spread of the data[2]
- 95% Control Limits
  - Inner control limits
  - 5 out of every 100 are expected to lie outside these limits
- 99.7% Control Limits
  - Outer control limits
  - 3 out of every 1000 are expected to lie outside these limits

2. Interpreting Funnel Plots

How to read a funnel plot

- Practices within the funnel/control limits show **common cause variation**
  - Common cause variation: variation caused by 'normal' events e.g. a roll of a regular dice
  - E.g. the blue dots show common cause variation if they are within the 99.7% control limits (bold dotted lines)
- Practices outside the funnel/control limits show **special cause variation**
  - Special cause variation: variation that is caused by special circumstances or events that are out of the ordinary e.g. game of dice where the dice has been tampered with
  - E.g. the blue dots show special cause variation if they are outside the 99.7% control limits (bold dotted lines)



1 https://fingertips.phe.org.uk/.../PHDS%20Guidance%20-%20Funnel%20Plots.pdf

[2] http://www.haelo.org.uk/funnel-plot/

What to do if your practice is outside the control limits?

- The 2018/9 NIS states that referral data should be used to prioritise areas of focus (Enablers 2018/19 NIS) and practices should 'document their PDSAs on LifeQI'. (Enablers 2018/19 NIS)

To document projects on LifeQI please follow the steps below

1) Start a new QI project on LifeQI
2) Obtain data for continuous time periods e.g. weekly/ monthly referral data
3) Plot data on a run chart on LifeQI
4) Identify points that may indicate non-random variation
5) Investigate possible causes for non-random variation. Make sure to note all findings on LifeQI
6) As a QI team, develop an aim and change ideas, which may affect the aim, and create PDSAs to reduce/increase measure. These may include peer review of referrals or the increased use of Advice & Guidance
7) Document reflections and PDSAs on Life QI

For more information about LifeQI: https://qi.elft.nhs.uk/resources/life-qi-resources/

3. Why Funnel Plots?

Why use funnel plots and not bar charts?

- Bar charts do not show us variation across the system
- Funnel plots allow us to clearly see variation and distinguish between expected/unexpected variation
- Funnel plots clearly identify outliers
- Funnel plots group practices by their list size rather than comparing all practices together
    - Accounts for any variation that may be caused by list size
- Funnel plots help us to prioritise activity e.g. focus on areas where we are an outlier

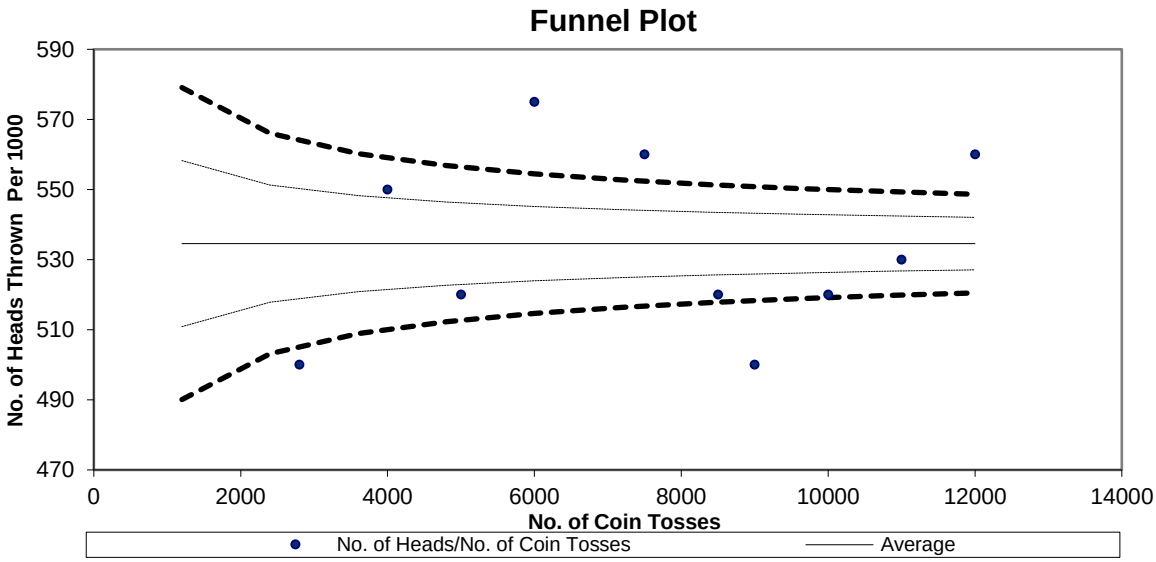
How does working with outliers affect system performance?

- Working with outliers affects system performance by reducing variation
- Reducing variation leads to an improvement in the efficiency of the health system and improves the predictability of outcomes

Why are the control limits shaped like a funnel?

- As sample size (or in our example - list size) increases, control limits narrow, giving a characteristic funnel shape
- Concept illustration
    - Imagine a scenario in which 36 GP practices are about to flip a coin
    - Object of the game is to throw as many heads as possible
        - Measure the rate of heads thrown by number of heads thrown per 1000 attempts…. rather than the raw number of actual heads thrown

- The reason why we are using the number of heads per 1000 attempts is that each of the GP practices have a differed number of coin tosses. This is going to be directly proportional to their list size
- E.g., a practice with a list size of 4000 patients will have 4,000 coin tosses. A practice with a list size of 10,000 will have 10,000 coin tosses.
- The practices then throw the dice and calculate how many heads they managed to roll per 1000 attempts



- The above funnel plot shows each GP practice (blue dots), how many coin tosses they had on the *x* axis and the number of heads per 1000 attempts on the *y* axis
- How does this explain why the funnel plot is shaped like a funnel?
    - There is a 50 % probability of getting heads when a coin is tossed. Therefore, we would expect roughly 50% of all coin tosses to produce heads.
    - However, with a low number of tosses, we can expect a significant amount of variation as there is a lower area of opportunity. E.g. with 5 tosses we can expect anywhere between 0 heads to 5 heads. This is why the control limits on the left are larger than on the right.
    - As we increase the number of tosses, because of probability we can expect roughly 50% of tosses to result in heads. For example, with 100 tosses we can expect roughly 50 heads. This is why the control limits on the right are narrower.
        - This shows that when the area of opportunity (coin tosses) is low, we can expect greater variation, which accounts for the mouth of the funnel. When the area of opportunity is greater, we expect less variation as the results would conform to probability.

Why do the points outside the funnel show special cause variation?

- Relating to our coin example, there is likely to be *significant variation in practices with less coins to throw*. As *more* coins are thrown, practices are more likely to achieve a long term or average result. This effect is known as 'regression towards the mean'.
- If a practice that has a considerable number of throws, say 100 throws, and this is wildly different from the mean or what we would expect, we can conclude that this is unusual and most likely, something influenced the result.
    - E.g. 100 coin tosses results in 75 heads. This shows that for this particular practice, they have a 75% possibility of getting heads. This is wildly different from the probability of getting heads generally, which is just 50%. We can then conclude that there has been special cause variation and we can start investigating.ss

4. Resources

For more information about funnel plots please refer to the following:

1) http://equiptowerhamlets.nhs.uk/qi-tools/
2) http://www.haelo.org.uk/funnel-plot/
3) Video: https://www.youtube.com/watch?v=0x_RIoL2EB8