

# CUSUM



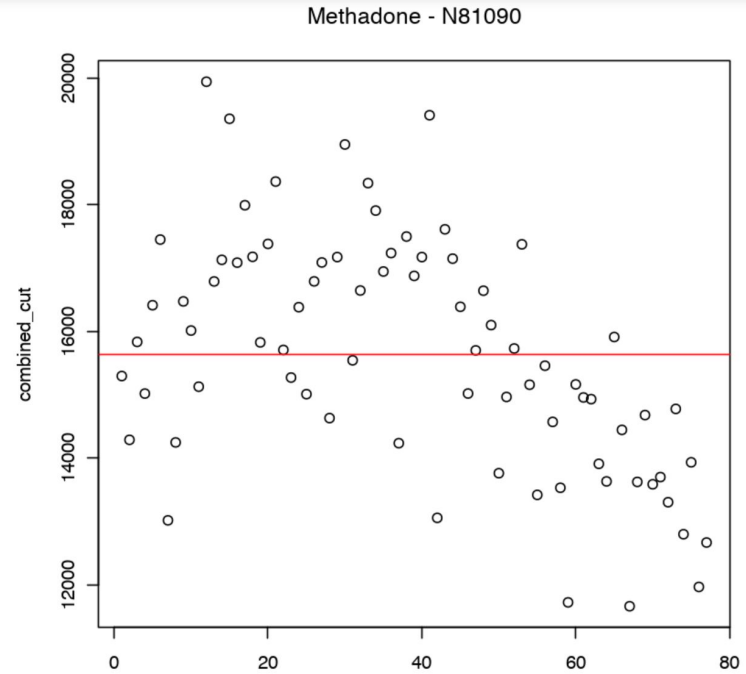
- CUSUM charts are based on sequential monitoring of cumulative performance over time rather than an average of past data. This allows them to filter out random noise or short-term non-systematic rate changes and to detect even small persistent shifts otherwise easily missed.
- Have been used to monitor healthcare outcomes such as hospital mortality.
- Can be constructed retrospectively on all time periods or prospectively based on an initial baseline of data.


# Defining a Signal



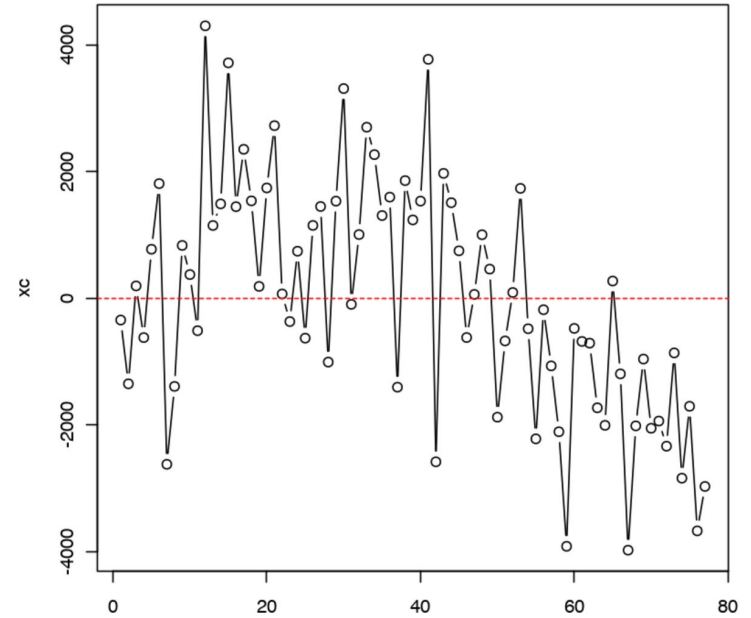
- Signals are defined by control limits constructed based on the mean and SD of the data. Signals are values that lie outside the control limits or violate SPC rules such as 8 consecutive points above the median.
- Limits have an inter dependence with the Average Run Length (ARL). The out-of control average run length (OC-ARL) is the average number of subjects required before the CUSUM chart signals when the level of performance is unacceptable, and the in-control average run length (IC-ARL) is the average number of consecutive subjects required for the CUSUM chart to signal despite the true rate being at an acceptable level.
- The occurrence of a signal does not necessarily imply deterioration in performance. A signal indicates a change in the outcome rate, the cause of which can only be determined through subsequent investigations
- Note that CUSUM is associated with false positive and false negatives. Simulating these (as in hospital mortality paper) can guide adjustment of the control limits.
- Ideal CUSUM design being one where the OC-ARL is short, and the IC-ARL is sufficiently long

Number of methadone prescriptions for a single practice over time.





Normalising this allows visualisation of variation around the mean.





Using CUSUM chart, a series of over-prescribing can be detected. Following an alarm (blue dots), signal is reset.

