

## CUSUM - A change in method of identifying outliers for SAP

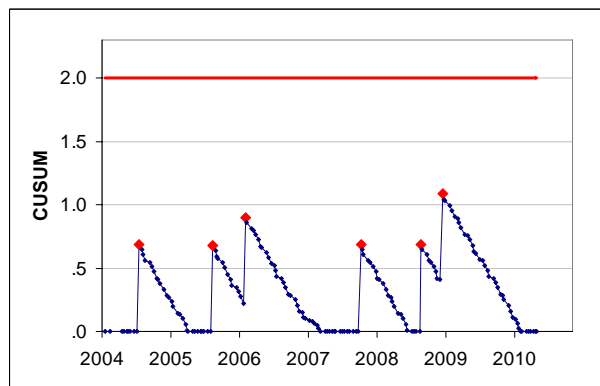
CUSUM stands for the **C**UMulative **S**UM of outcomes and is a relatively new graphical tracking measure of adverse events.

On the example graph below, each blue dot represents successive arthroplasty operations from one consultant.

The CUSUM value increases if there is a complication after the operation (red diamond), and decreases if not. As complications are rare events they cause a large increase in CUSUM. This is counteracted by lots of small decreases in CUSUM from operations with no complication.

The size of the increase in CUSUM after a complication, or the decrease after an operation with no complication is calculated statistically and is casemix adjusted. The CUSUM is not allowed to fall below zero, so periods of higher complication rate are not masked by previous periods when the complication rate was low.

If a surgeon's complication rate is close to or below average, their CUSUM will hover not far from zero, as in the example below. In this case, CUSUM remains below the red line – the consultant is not an outlier.



If the CUSUM rises to the red Control Limit line the consultant will be alerted of an unusually high complication rate. They will be asked to review their complications and complete the usual Action Plan for assessment by the SAP Steering Committee

The value of the red Control Limit line (in this case=2) is a management decision that allows us to balance the risks of false Alerts (occurring by chance when the surgeon's complication rate is in control), and the risk of not detecting an unacceptable change in complication rate. SAP have chosen a Control Limit of 2 because this allows detection of outliers for as few as four complications in quick succession.

### **Two examples of Outliers**

In the left-hand case, CUSUM rises steadily to the Control Limit (2.0). The complication rate is always slightly over average - is there an ongoing issue? When the Control Limit is reached in 2010, the consultant would be notified that their complication rate had been unusually high and asked to complete a review and Action Plan.

In the right-hand case, CUSUM is low until it rises suddenly to the Control Limit in 2009. Is the rise associated with a change in practise, perhaps a new technique?

