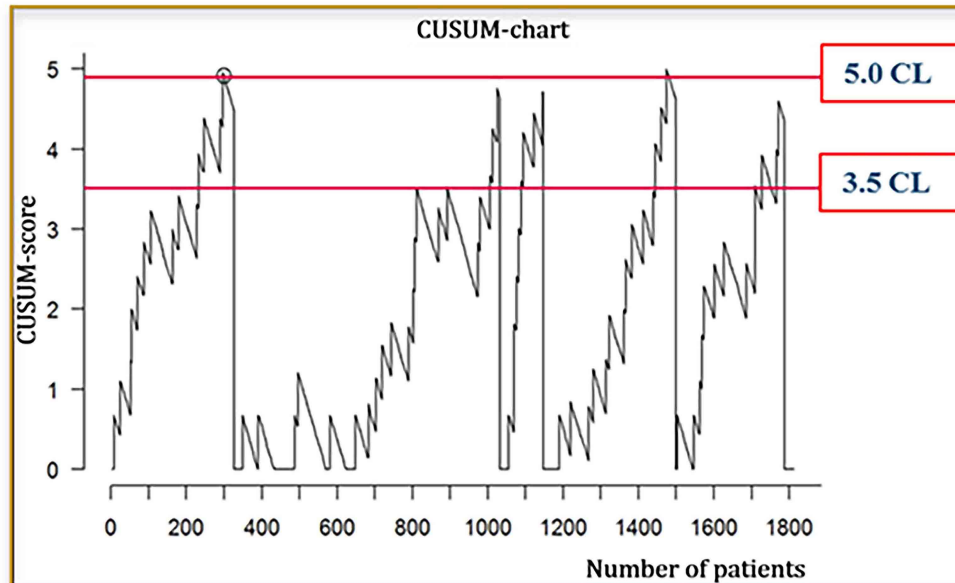**Leiden University Medical Center**

CUSUM-chart
Things you should know

A Cumulative sum (CUSUM) chart can be used to monitor continuously for every patient whether performance is as expected or becomes worse than expected.


CUSUM-chart

1. For every consecutive patient, the observed (O) minus expected (E) probability for an event is plotted.
2. When the score goes upward this means that the observed performance for that patient is worse than expected, vice versa when going down.
3. A signal (alert) is generated when crossing the control limit (CL). The chart is reset to zero.
4. A higher CL means we are increasingly certain this is a true signal. CL 5.0 thus has fewer false positive signals but could miss cases of worse performance. The opposite applies to 3.5 CL.

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Funnel-plot
Things you should know

Funnel-plots are recommended as a graphical aid to show the variation between hospitals in performance, and identify hospitals performing worse (in red) or better (in green) than expected

Funnel-plot of hospital variation for a binary outcome
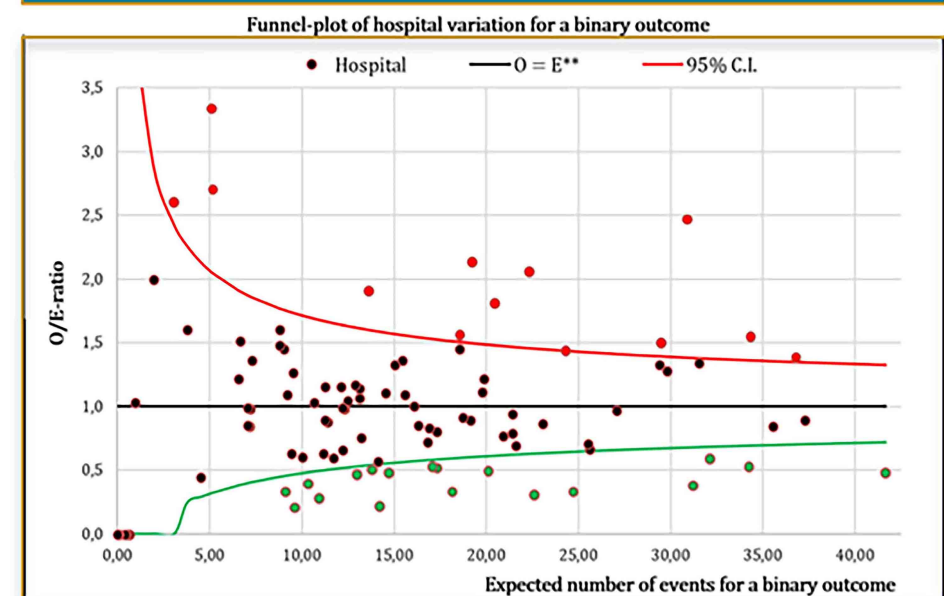
1. The expected probability on an outcome is calculated for each patient given e.g. age, comorbidity and smoking. These probabilities are summed for all patients treated in a hospital to calculate the expected number.
2. The O/E-ratio is the observed number of events divided by the expected number number of events for a hospital.
3. When O/E-ratio=1, the observed number equals the expected number of events in that hospital.
4. Hospitals plotted between the two control limits have a performance that is not statistically different from what is expected based on their patient-mix.
5. Hospitals plotted above the upper control limit have more events than expected based on their patient mix (performing worse) – negative outliers.
6. Hospitals plotted below the lower control limit have fewer events than expected based on their patient mix (performing better) – positive outliers.