

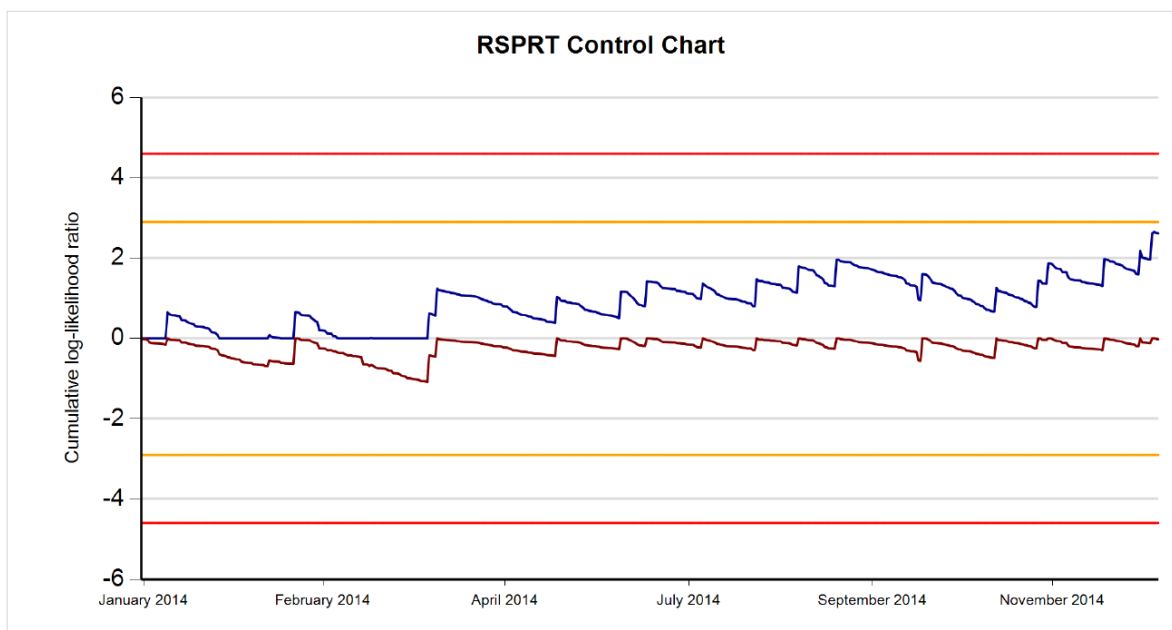
Risk-adjusted resetting sequential probability ratio test plots

The technical explanation

The risk-adjusted resetting sequential probability ratio test plots are generated to display the cumulative probability of a doubling or halving of odds of mortality for each patient against predefined thresholds. This is done using the likelihood ratio test (Equation) where $P_0(x)$ is the probability of observing the data under H_0 and $P_1(x)$ under H_1 (Steiner et al, 2000; Spiegelhalter et al, 2003). The plots are constructed in two parts: the lower half indicates the likelihood of a halving of the odds of mortality and the upper half a doubling. Lower and upper threshold values have been set at -2.94 and 2.94 and -4.60 and 4.60 representing Type I and Type II error rates with a probability of 0.05 and 0.01 respectively. Resetting occurs if either line hits zero or the lower/upper thresholds at a probability of 0.01.

$$LLR = \sum_i \ln(P_1(x_i)/P_0(x_i))$$

Equation



What this means

Above the 0 line we plot the 'log-likelihood' of a doubling of the odds of mortality, based on what is predicted by PIM3, and below the zero line we plot the same thing for a halving of the odds of mortality. We do this by taking the PIM3 score for each patient on admission and their discharge status (alive or dead) and calculating the tests for halving and doubling after each admission. Until there is a death, the top line in your graph stays flat (there is no likelihood of a doubling of odds) and the bottom line gradually drops as the cumulative likelihood of a halving of the odds increases, because each patient has a small expected

probability of dying but doesn't. When a death occurs, the top line moves up, indicating an increased likelihood of the doubling of the odds of mortality. The bottom line will also move nearer to zero.

Between the orange 'tramlines' is a 'safe zone' with the variability you might expect day to day. Between the orange and red lines at the top of the chart can be regarded as a 'warning zone' where you are seeing an increased likelihood that the odds are close to doubling. If the bottom line drops into the lower orange-red sector it means that you are more likely to be seeing a halving of the odds. In both cases, if the line touches the red line the chart 'resets' itself to ensure that you are looking real-time trends rather than over the longer term.

You must remember that although this plot is using statistical techniques it is up to you to interpret what is happening clinically. The plot gives you an indication from the data derived from PIM3 and PICU outcome about whether you are seeing expected or 'out of control' performance but this could just be a simple reflection of what you already know is happening.

Refs

Spiegelhalter DJ, Grigg OA, Kinsman R, Treasure T. Risk-adjusted sequential probability ratio tests: applications to Bristol, Shipman and adult cardiac surgery. *Int J Qual Health Care* 2003; 15:7–13.

Steiner SH, Cook RJ, Farewell VT, Treasure T. Monitoring surgical performance using risk-adjusted cumulative sum charts. *Biostat* 2000; 1:441-452.