Background

Recent calls for continuous monitoring of large-scale public health interventions in low-income countries have coincided with the increased use of routine monitoring for outcomes after episodes of care in high-income settings. Graphical methods have become available to monitor short-term outcomes adjusted for patients’ risk. However, there are no documented examples of these tools being used to monitor mortality outcomes in low-income settings.

As well as facilitating routine monitoring activities, graphical displays of outcomes with time can also suggest avenues for academic research by enhancing the interpretation of data. This in turn can shed light on the potential mechanisms that underlie the observed effects. Here we discuss the use in a low-income setting of one such graphical method, the variable life adjusted display (VLAD). Its advantages are that the charts are easy to understand and can alert users quickly if the outcomes observed are worse than predicted. We briefly describe this method and its uses, and illustrate how it was used with data from a recent trial that studied neonatal deaths in India.

Use of VLAD

The VLAD method was devised to present time-ordered peri-operative outcomes after cardiac surgery, adjusted for individual patients’ risk and based on an established risk scoring system. It has since been adopted internationally as a standard monitoring tool for mortality after cardiac surgery and in many other contexts. The VLAD method does not provide “statistical proof” of an effect; however, it does provide an excellent mechanism for rapidly identifying unusually favourable or unfavourable outcomes that might warrant study.

VLAD method

Here we provide a brief description of the technique. A full description is available at http://www.ucl.ac.uk/operational-research/AnalysisTools/VLAD and elsewhere. The method is suitable for any binary short-term outcome; here we consider neonatal survival after live birth.

A VLAD chart shows the difference between the expected numbers of deaths and the numbers of deaths observed with time. As originally designed, the expected numbers of deaths with time was determined by estimating individual risk, but the same risk of death can be used for all individuals. This latter approach is well suited to monitoring individual-level outcomes after public health interventions. For these contexts risk of death can be an observed or target mortality rate.

If the baseline probability of neonatal death is given by \( P \), where \( P \) is a number between zero and 1 (e.g. a mortality rate of 20% would yield \( P = 0.2 \)), then on average every live birth would be expected to result in \( P \) neonatal deaths. By assigning a value of 1 to an observed neonatal death and a value of zero to an observed survival, the score associated with each live birth can be calculated as (expected outcome) minus (observed outcome). Thus, if a baby dies, that birth is associated with a score of \( P - 1 \) (less than zero), and if a baby survives then that birth is associated with a score of \( P \) (greater than zero). The VLAD score is the cumulative total of scores with time and represents the cumulative difference between expected and observed deaths. If this difference is greater than zero there have been fewer deaths than expected, and if it is less than zero then there have been more deaths than expected. A VLAD chart is constructed by plotting the VLAD score with time, which reveals trends in outcomes. Subgroups (e.g. trial arms, different geographical regions or individual hospitals) can be plotted separately, with multiple traces on the same VLAD chart.

We illustrate the use of VLAD with data from an intervention that involved local women’s groups discussing issues related to maternal and newborn health in eastern India. The intervention was rigorously evaluated in a cluster-randomized controlled trial which ran from 31 July 2005 to 30 July 2008, and resulted in a 32% (odds ratio: 0.68, 95% confidence interval: 0.59–0.78) reduction in neonatal mortality. Secondary indicators showed changes in various behaviours associated with outcomes (for example, immediate breastfeeding), but the nature of the intervention means that the mechanisms behind the observed results were complex. Moreover, group members were to start implementing chosen strategies after a few months, so that immediate impact was unlikely. Awareness of the lag time before improvements in outcomes become observable can aid future planning.

Baseline data were collected from 21 November 2004 until 30 July 2005. The women’s group intervention started on 31 July 2005. Overall neonatal mortality rate in both arms of the trial during the baseline period was 58 neonatal deaths per 1000 live births, so we used \( P = 0.058 \) as the baseline probability of death for the VLAD chart. Between 2004 and 2008, we obtained validated outcome data for 22 706 live births. The VLAD plot for the intervention and control arms is shown in Fig. 1.

Interpreting the VLAD plot

Our interpretation assumes that the differences observed between the control and intervention arms were due to the implementation of the women’s group intervention.

Lag time

The control and intervention arms had broadly similar outcomes in the baseline
The process for producing a basic VLAD chart is simple, requiring only straightforward data manipulation skills. However, it is important to bear in mind the caveats discussed above when interpreting these charts, particularly the importance of periodically reviewing the baseline risk estimates. An application for Excel 2003® (Microsoft Corporation) that can be used to produce VLAD charts with an academic licence is available free from the corresponding author.

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