

ANZDATA 2016 Individual Hospital Report Methodology Changes

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The 2011-2016 ANZDATA individual hospital reports (Dialysis and Transplantation) include improved methodology for comparing hospitals in terms of the ratio of the number of observed events to the number expected events.

The options considered for how the 'expected' events would be defined are outlined below. The methodology chosen to be implemented for these reports (option 4) defines the expected number of events as the number of events expected if the patients treated at that hospital had instead been assigned at random to any hospital in Australia and New Zealand, with the random assignment weighted by hospital size. This option was chosen by the ANZDATA Key Performance Indicators working group, as it reflects what could be expected for patients in the overall population, and it accounts for centre size.

The models used to estimate the expected events include a number of patient characteristics (eg age, sex, ethnicity, comorbidities, etc.) and a random effect for each parent centre to account for unexplained variation by centre. This unexplained variation is likely to comprise treatment-related and unrelated factors (i.e. factors within and outside the control of the centre) The model used by ANZDATA has included a random effect for the last three reports produced (for data up to end of 2013, 2014 and 2015). The model used for derivation of the coefficients in each instance uses a random effect; this is standard practice. However, an important issue which then arises is whether (and how) the random effect for each centre is incorporated when estimating the expected number of events for that centre. Different ways of accounting for this are discussed further below.

In addition, we have modified the methodology to better control false discovery rates, (Benjamini and Hochberg, 1995) to account for the multiple comparisons made between centres. To this end, false discovery rate (FDR) confidence intervals are provided for the ratios of observed to expected events (Jones et al., 2008). In the funnel plots below we have included the previously used 95% and 99% confidence intervals, but only the FDR intervals are provided in the published reports.

With the change in the definition of the expected events, the standard error of the ratios of observed to expected events were estimated using 500 bootstrapped samples. This change resulted in the funnel plot x-axis presenting the effective sample size. The SMR is also presented on a logarithmic scale as confidence intervals for the logarithm of the SMR (log-SMR) have better coverage properties (Hosmer and Lemeshow, 1995). The effective sample size measures the variability of the log-SMRs relative to the total variability of all log-SMRs (Kasza et al., 2013). In doing so, the effective sample size reflects the size of the hospital and the homogeneity of the patients within that hospital. Illustrative funnel plots based on the number of deaths are also included in this document for comparison.

Accounting for random effects in calculating expected event number

Four options for the definition of the number of expected events were considered, as summarised in Table 1 below. Each option is then elaborated on in more detail, with funnel plots for dialysis centres from 2010 to 2015 are presented as an example.

Table 1: Summary of the four options considered for the expected number of events

Option	Random effect	Predicted probability definition for expected events
1	No	N/A
2	Yes	Patients were treated at their particular centre
3	Yes	Patient was randomly assigned to a centre within Australia and New Zealand
4	Yes	Patient was randomly assigned to a centre within Australia and New Zealand, weighted by centre size

Option 4 was implemented, as it reflects what could be expected for patients in the general population, and it accounts for centre size.

Option 1

No random effect in model for expected number of events

In this option, the predicted probability of an event is calculated for each patient on the basis of the measured patient characteristics alone. These probabilities are summed for each centre to give the expected number of events.

Figures 1, 2 and 3 show funnel plots for dialysis centres for the period 2010-2015 using the SMR definition of option 1. The funnel plot shows the log-SMR of each centre against their effective sample size, which is a measure of the variability of the SMR estimate. Contour lines are shown for 95% and 99% confidence limits, which an individual centre has that probability of lying within. Also shown are contour lines of the 95% false discovery rate (FDR) confidence limits. These limits control for the multiple comparisons made by considering all 84 centres, and maintain the probability of incorrectly concluding an individual centre is extreme at 0.05. Six centres (7%) are above the upper FDR contour line, and five (6%) are below the lower FDR contour line.

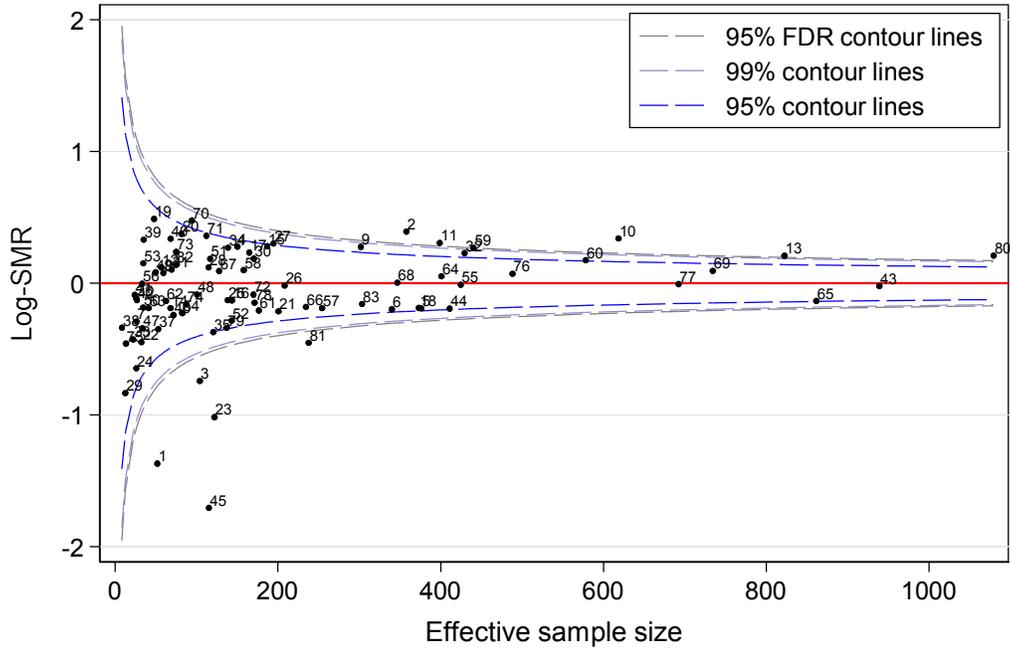


Figure 1: Funnel plot for option 1 with log-SMR against effective sample size.

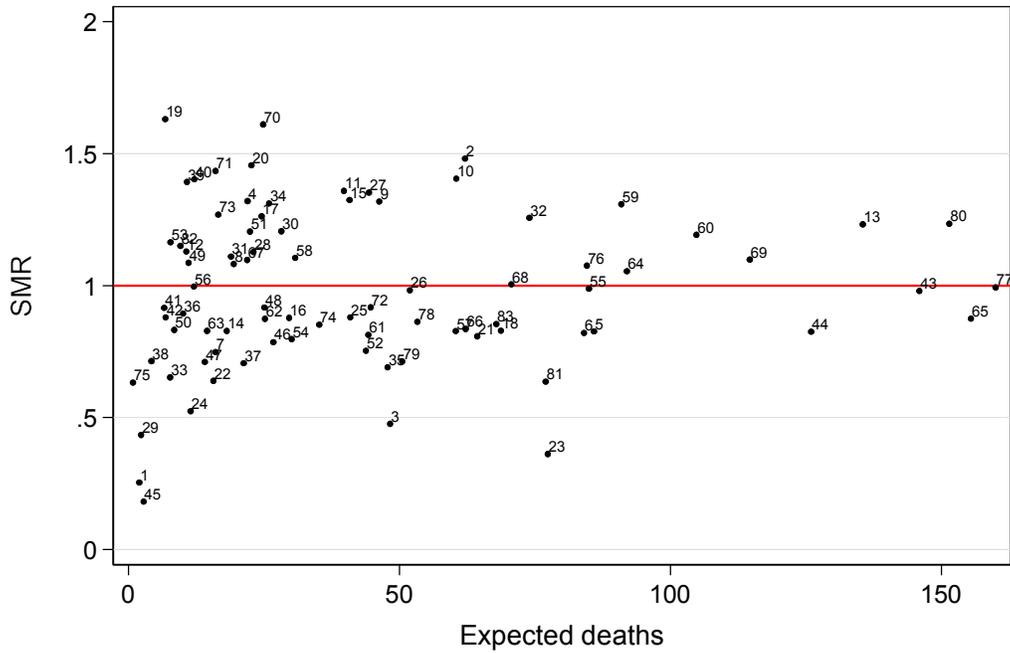


Figure 2: Funnel plot for option 1 with SMR against expected deaths, without contour lines.

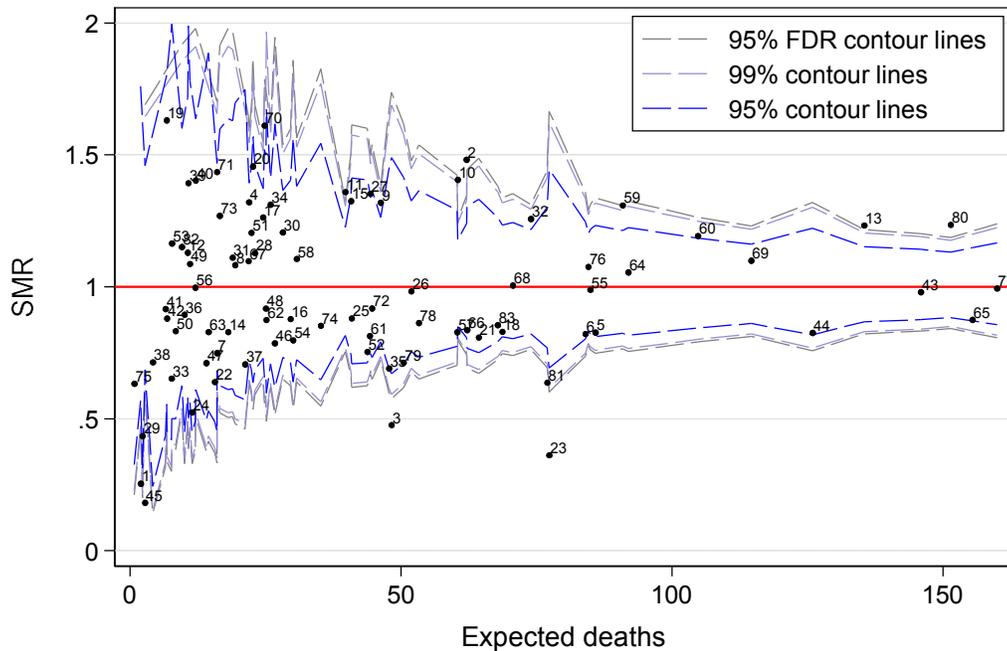


Figure 3: Funnel plot for option 1 with SMR against expected deaths, showing contour lines.

Option 2

Random effect in model for expected events; predicted probability of an event is given patients were treated at their particular centre

In this option, the predicted probability of an event is calculated for each patient including their measured characteristics and the random effect for their particular centre. These probabilities are summed for each centre to give the expected number of events.

This is the option that was used for the last three years of ANZDATA hospital reports. However the use of a predicted probability which is given treatment at a particular centre is contrary to the concept that the expected events in an SMR should be for the 'general population'.

Figures 4, 5 and 6 show funnel plots for dialysis centres for the period 2010-2015 using the SMR definition of option 2. 18 centres (22%) are above the upper FDR contour line, and five (6%) are below the lower FDR contour line.

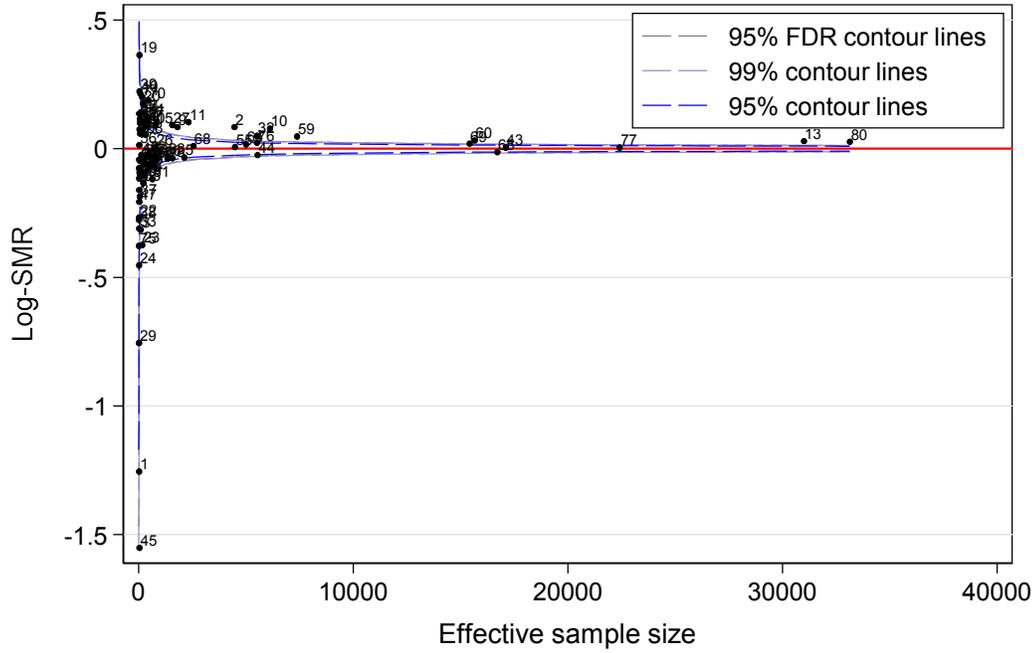


Figure 4: Funnel plot for option 2 with log-SMR against effective sample size.

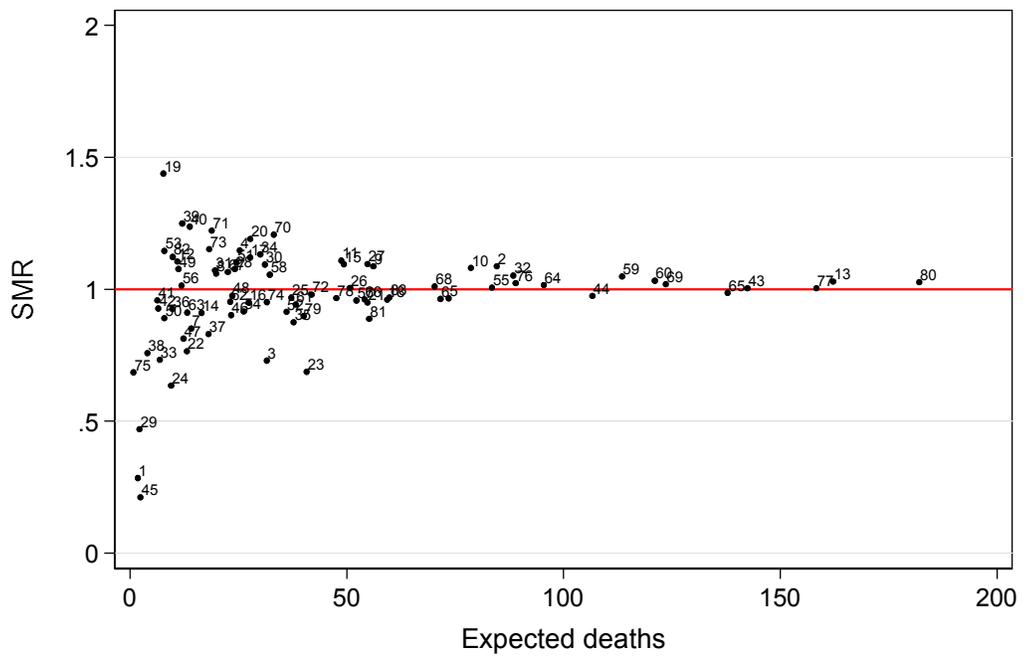


Figure 5: Funnel plot for option 2 with SMR against expected deaths, without contour lines.

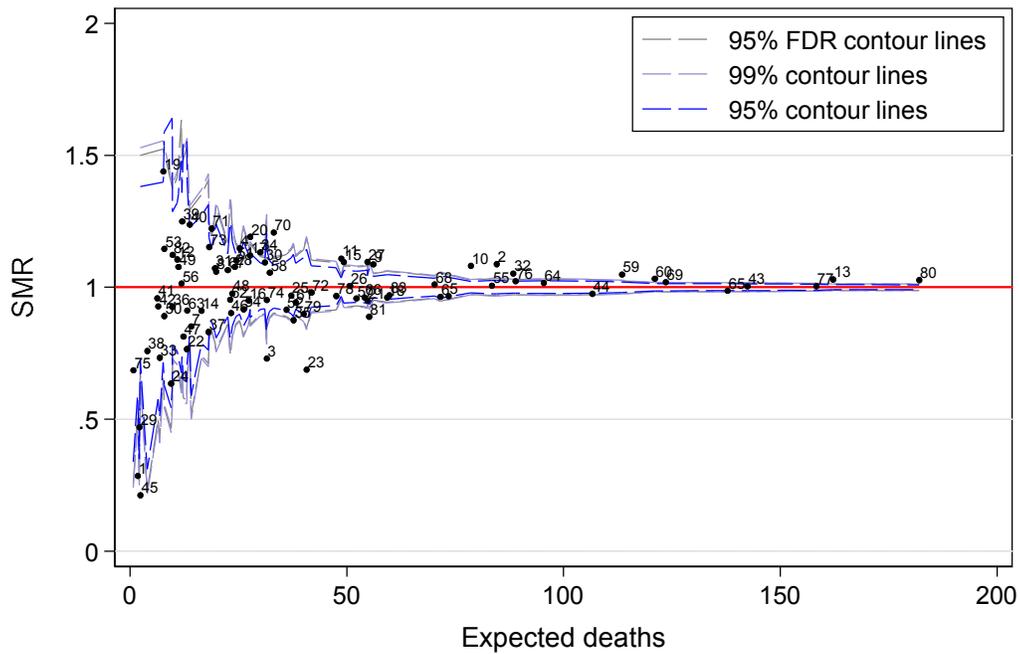


Figure 6: Funnel plot for option 2 with SMR against expected deaths, showing contour lines.

Option 3

Random effect in model for expected events; predicted probability of an event is under the assumption patient was randomly assigned to a centre within Australia and New Zealand.

In this option, the expected number of events is defined as the number of events expected if the patients treated at that centre had instead been assigned at random to any centre in Australia and New Zealand. For each patient, predicted probabilities of an event had that patient been treated in each available centre were calculated, then averaged. These average predicted probabilities are summed for patients within each centre to give the expected number of deaths.

Figures 7, 8 and 9 show funnel plots for dialysis centres for the period 2010-2015 using the SMR definition of option 3. Five centres (6%) are above the upper FDR contour line, and five (6%) are below the lower FDR contour line.

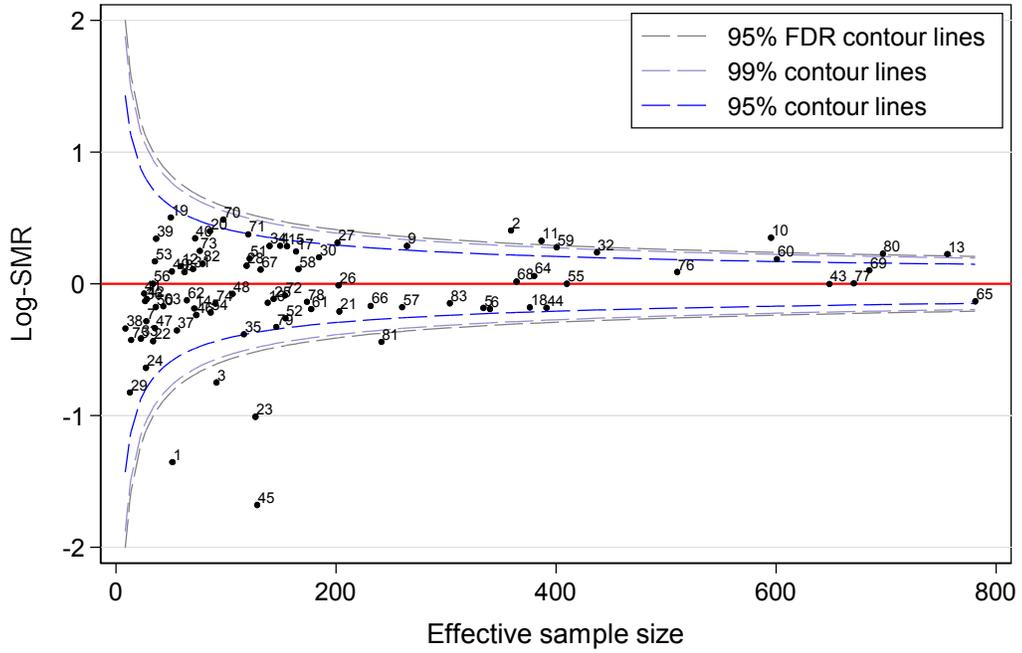


Figure 7: Funnel plot for option 3 with log-SMR against effective sample size.

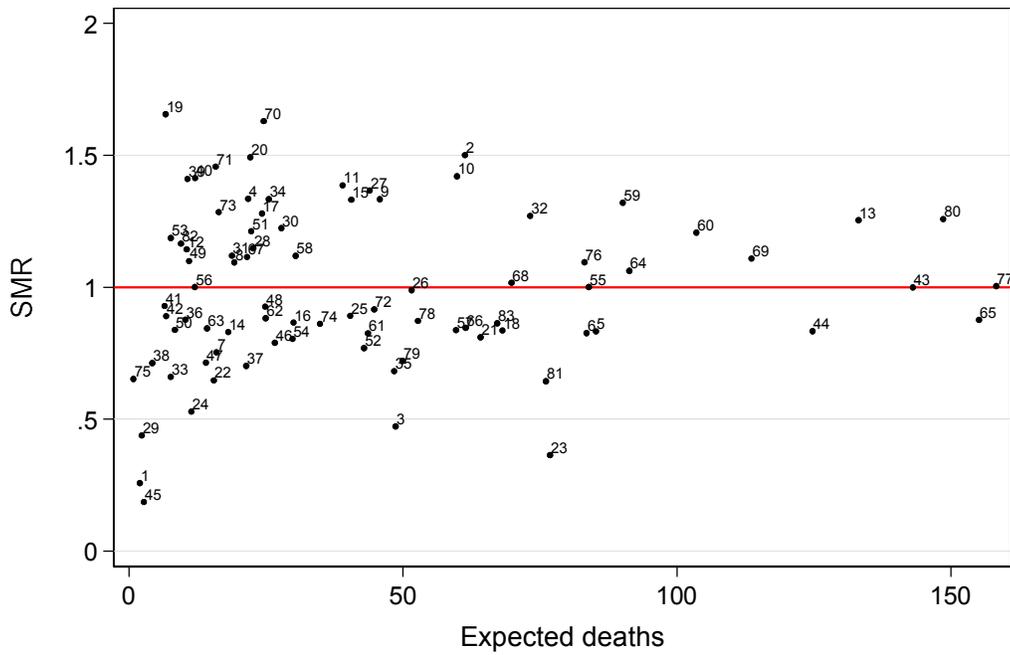


Figure 8: Funnel plot for option 3 with SMR against expected deaths, without contour lines.

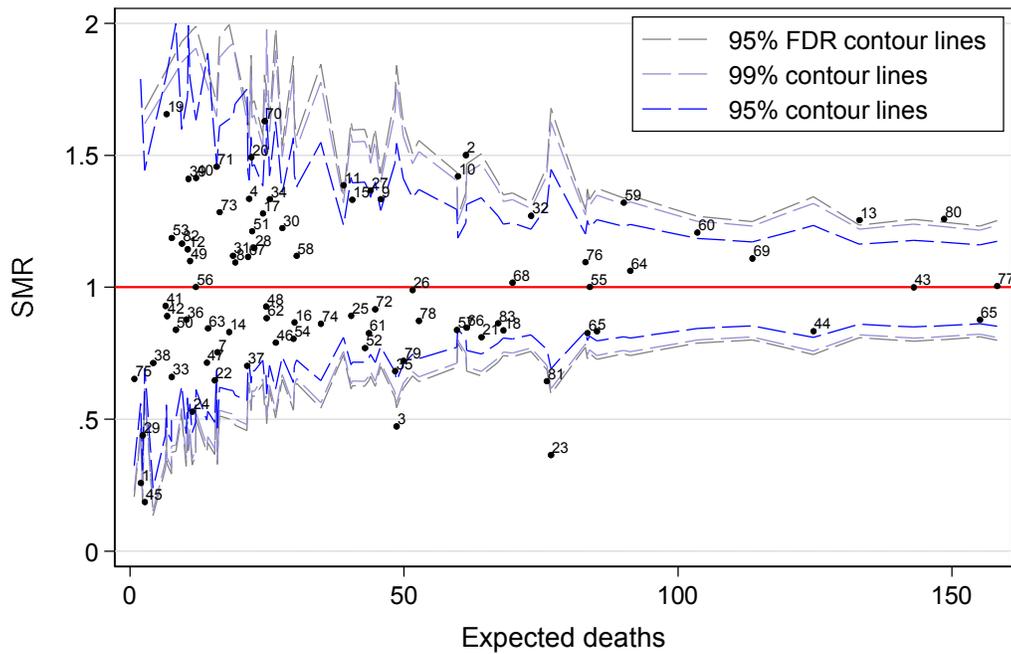


Figure 9: Funnel plot for option 3 with SMR against expected deaths, showing contour lines.

Option 4

Random effect in model for expected events; predicted probability of an event is under the assumption patient was randomly assigned to a centre within Australia and New Zealand, weighted by centre size.

In this option, the expected number of events is defined as the number of events expected if the patients treated at that centre had instead been assigned at random to any centre in Australia and New Zealand, with the random assignment weighted by centre size. For each patient, predicted probabilities of an event had that patient been treated in each available centre were calculated, then a weighted average was taken. These weighted average predicted probabilities are summed for patients within each centre to give the expected number of deaths.

Figures 10, 11 and 12 show funnel plots for dialysis centres for the period 2010-2015 using the SMR definition of option 4. Four centres (5%) are above the upper FDR contour line, and five (6%) are below the lower FDR contour line.

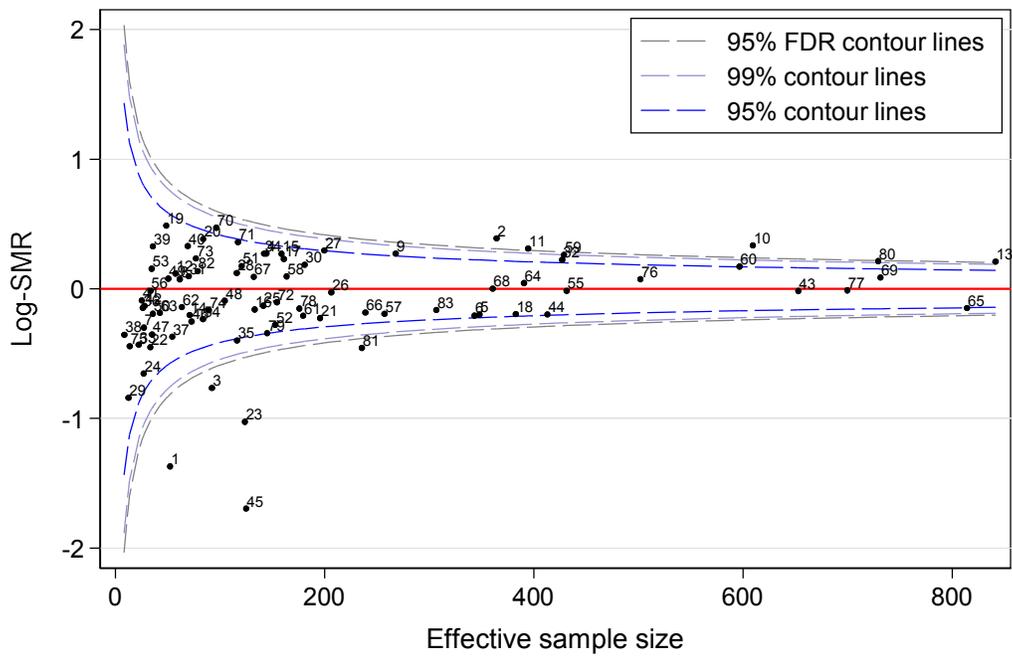


Figure 10: Funnel plot for option 4 with log-SMR against effective sample size.

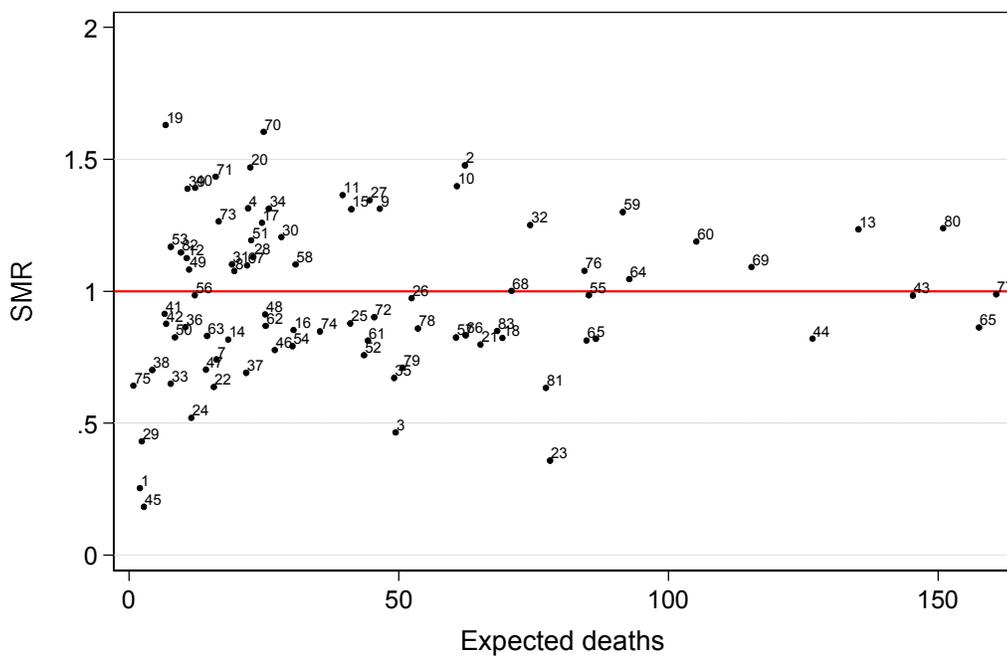


Figure 11: Funnel plot for option 4 with SMR against expected deaths, without contour lines.

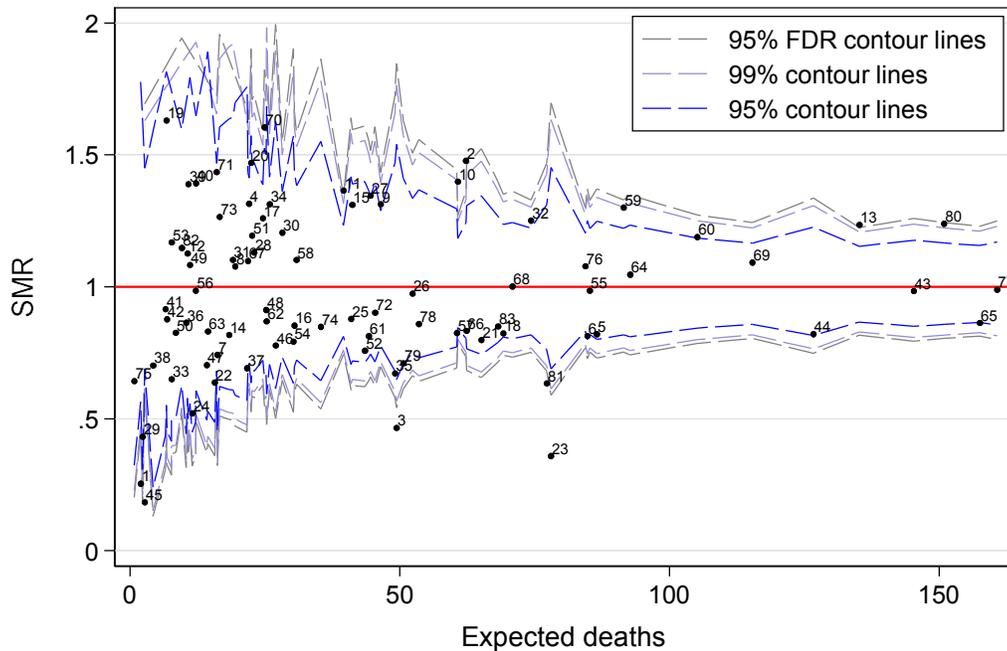


Figure 12: Funnel plot for option 4 with SMR against expected deaths, showing contour lines.

Discussion

While option 2 is not consistent with the concept that the expected deaths in an SMR should be for the 'general population', options 1, 3 and 4 have the potential limitation that they are not conservative estimates of the SMR in terms of unmeasured patient characteristics. If such characteristics were to cluster by centres, these would be interpreted as centre specific differences rather than differences in the patient case-mix.

These options were circulated among the ANZDATA Key Performance Indicators working group and other statistical advisors; option 4 was chosen as it was felt to best reflect what could be expected for patients in the general population, and accounted for centre size.

References

Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society. Series B.* 1995; 57:289–300.

Hosmer DW, Lemeshow S. Confidence interval estimates of an index of quality performance based on logistic regression models. *Statistics in Medicine* 1995; 14:2161–2172.

Jones HE, Ohlssen DI, Spiegelhalter DJ. Use of the false discovery rate when comparing multiple health care providers. *Journal of Clinical Epidemiology* 2008; 61:232–240.

Kasza J, Moran JL, Solomon PJ, et al. Evaluating the performance of Australian and New Zealand intensive care units in 2009 and 2010. *Statistics in Medicine* 2013; 32(21):3720-36.