

NJR Implant Performance Analysis Methodology

Purpose: to use the data collected by the NJR about joint replacement surgery in order to provide an early warning of issues relating to patient safety. This includes issues around the comparative performance of implants and implant combinations.

Goals: to support suppliers in the routine post-market surveillance of implants and provide information to clinicians, patients, hospital management and the regulatory authorities. It is worthy of note that this process is not a substitute for pre-market properly designed and conducted randomised trials for new implant designs.

Implant performance analysis

Aim: To detect primary implants with particularly high (or low) revision rates

Indicator: Person time incidence rates with 95% confidence intervals (CIs)

Person time incidence rates (PTIR)

Definition: the number of new cases (in this context revisions) per population at risk in a given time period. The NJR expresses the PTIR as the number of revisions per 100 patient years at risk.

Denominator: the sum of the person-time of the at risk population expressed as person years. For example, 100 person years could mean:

- 10 persons followed for 10 years
- 100 persons followed for 1 year
- 200 persons followed for 6 months

Comparator: the PTIR for a particular implant or brand are referenced against the group PTIR so in order to conduct that comparison, we need to know:

- Brand number of primaries
- Brand PTIR and corresponding upper and lower limits of 95% CIs
- 'Group' PTIR and corresponding upper and lower limits of 95% CIs
- Criteria for the thresholds of interest which are defined *a priori*

Group PTIR: An estimate of the PTIR that would be expected for the brand, based on the proportions of implants that are (i) cemented, uncemented, hybrid, reverse hybrid or resurfacing for hips and (ii) cemented, uncemented, hybrid, patellofemoral and unicondylar for knees; rates for these groups being derived from the whole hip or knee cohorts.

Calculation:

Brand PTIR	=	Number of first revisions of brand over analysis period
		Total time all implants of this brand have been at risk of revision

As an example, the overall rates in 2016 were 0.53 (95%CI 0.53-0.54) per 100 patient-years in hips and 0.49 (95%CI 0.49-0.50) in knees.

Outlier status: in order to define whether an implant is an outlier, its PTIR and associated 95% confidence intervals are compared with the group PTIR and its 95% confidence intervals. Different thresholds are defined for different levels of outlier status (e.g. 2 times the group rate for level 1 and 1.5 times the group rate for level 2). In order to allow for any imprecision in the estimates around the calculation of the group rates and their multipliers, the upper 95% confidence interval is used as the threshold for comparison to the brand rate. The lower 95% confidence interval of the brand rate must therefore exceed the upper 95% confidence interval of threshold of interest. It is worth noting that the number of cases that contribute to the calculation of the group rates are now so large that the width of the 95% confidence interval is becoming negligible (typically in the order of PTIR 0.05).

Level 1 outlier status (figure 1): this is the highest level of outlier. To define whether an implant has a rate of revision that makes it a level 1 outlier above the group revision rates:

- There must have been more than 100 primary procedures where the implant has been implanted (implants used in less than 100 cases are excluded from level 1 outlier classification)
- The brand or implant PTIR must be **at least two times higher** than the group PTIR.

To do this the levels of uncertainty in the PTIR estimates (i.e. the 95% CIs) are taken into account, thus the lower limit of the brand or implant 95% CI must exceed the upper limit associated with a **doubling** of the group rate.

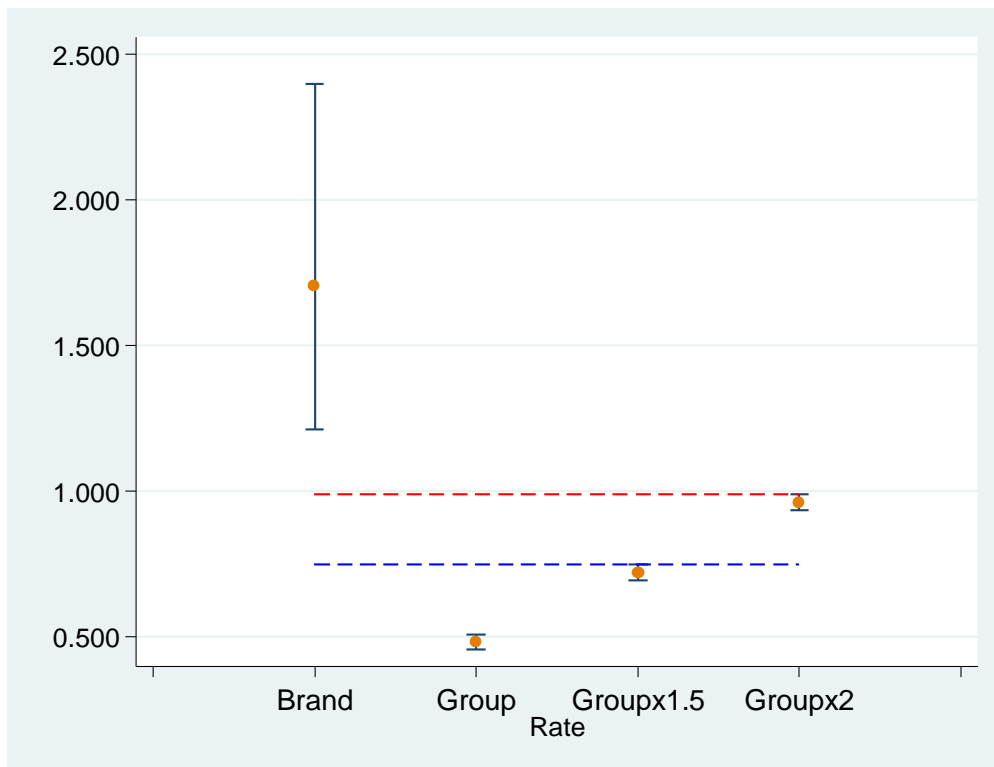


Figure 1: Illustration of level 1 outlier

- Figure 1 demonstrates a theoretical knee prosthesis with more than 100 implantations and a brand rate PTIR of 1.70 (95% CI: 1.21,2.40). In order to determine the group rate, the proportion of the implanted brand that were cemented, uncemented, hybrid, patellofemoral and unicondylar replacements is calculated. The group rate is then calculated according to the same proportion across the whole knee cohort, in this case the group rate PTIR is 0.48 (95% CI: 0.45,0.51). The blue dashed line indicates the upper 95% confidence interval of the 1.5 times the group rate estimate and the red dashed line, the upper 95% confidence interval for 2 times the group rate estimate. It can be seen that the lower 95% confidence interval of the brand PTIR exceeds both of these and therefore the implant is a level 1 outlier.

Level 2 outlier status: this is the second level of outlier status and can apply to implants with either less than 100 implantations or those with more than 100 implantations.

Level 2 outlier status with more than 100 primary implantations (figure 2):

- The brand or implant PTIR must be at least **1.5 times** greater than the group PTIR and the lower limit of the brand or implant 95% confidence interval must exceed the upper limit associated with a 50% increase in the group rate (but not a doubling, which otherwise would define level 1).

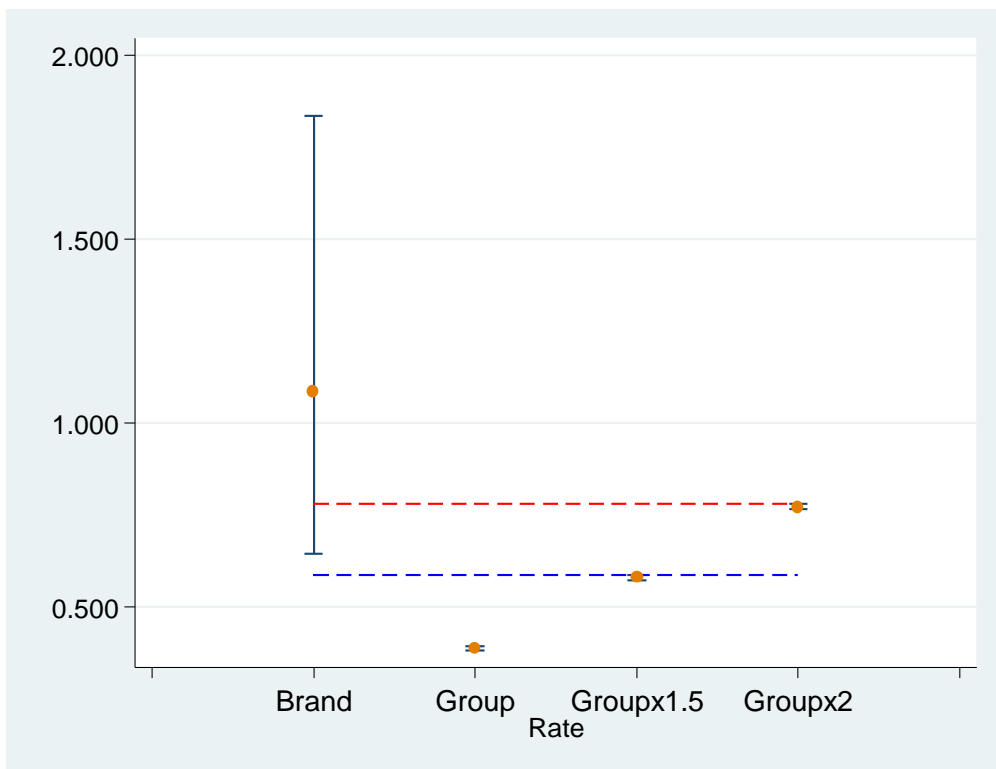


Figure 2: Illustration of level 2 outlier

- Figure 2 demonstrates a theoretical knee prosthesis with more than 100 implantations and a brand rate PTIR of 1.09 (95% CI: 0.64,1.83). In order to determine the group rate, the proportion of the implanted brand that were cemented, uncemented, hybrid, patellofemoral and unicondylar replacements is calculated. The group rate is then calculated according to the same proportion across the whole knee cohort, in this case the group rate PTIR is 0.39 (95% CI: 0.38,0.39). The blue dashed line indicates the upper 95% confidence interval of the 1.5 times the group rate estimate and the red dashed line, the upper 95% confidence interval for 2 times the group rate estimate. Even though the brand PTIR

is more than double the group PTIR, it can be seen that the lower 95% confidence interval of the brand PTIR exceeds only the upper 95% confidence interval for 1.5 times the group rate and therefore this implant is a level 2 outlier.

Level 2 outlier status with fewer than 100 primary implantations:

- The brand or implant PTIR must be at least two times greater than the group PTIR with consideration of the levels of uncertainty, as for level 1.

Limitations

PTIR: Assumes the hazard rate (the risk of revision at any point in time given the implant has not been revised up to that point in time) is constant across the whole time implants are at risk of revision.

Registry data: Can demonstrate association but when considered in isolation, not causation.