From registries to residents: evaluating the outcomes of hip and knee replacements in surgical training

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As surgical training evolves to meet increasing clinical demands and ongoing workforce challenges, successful patient outcomes with trainee-led procedures must be ensured. Hip and knee replacement surgery reliably provides excellent clinical results and as high-volume procedures, they provide ideal opportunities for supervised learning. However, some may have concerns regarding potential increased risks when these procedures are performed by trainees.

The National Joint Registry (NJR) gives objective evidence of a surgeon's whole arthroplasty practice and presents performance analysis through the annual Consultant Level Report (CLR). Consequently, some consultant trainers may be cautious in allowing trainees to perform hip and knee replacement surgery under their name, particularly if they feel trainee-led procedures have inferior outcomes that will count against them in their CLR analysis.

Ensuring high-quality surgical training whilst maintaining patient safety is central to orthopaedic practice and recent evidence confirms that, with appropriate supervision, the outcomes of trainee-led arthroplasty are comparable to those of consultants. This article aims to explore NJR surgeon performance analysis and contemporary data on patient outcomes with trainee-led hip and knee replacement surgery.

Challenges to surgical training

The landscape of surgical training has changed and trainees face significant challenges. Operative exposure is increasingly limited due to service pressures, working time restrictions and the outsourcing of low-complexity cases to the independent sector. Those that remain within NHS care are often medically or surgically complex and maybe less suitable to trainee-led surgery. The impact of COVID-19 continues to be felt with long elective backlogs and an emphasis on productivity still affecting training schedules. Workforce shortages often lead to trainees being diverted to service-based tasks and the increasing use of novel surgical approaches and robotic technology further limit training opportunities as consultants gain experience for themselves. Additionally, the increasing burden of peri-prosthetic fracture and prosthetic joint infection requires dedicated resources with undesirable consequences for training.

These factors contribute to reduced operative time for orthopaedic trainees and restrict the hands-on experience required to achieve total joint replacement indicative numbers (currently standing at 80 cases) stipulated for Certificate of Completion of Training (CCT). These challenges necessitate strategic planning, mentorship and institutional support to avoid unwelcome training extensions and to ensure trainees acquire the skills needed to become confident and competent consultants.

Effect of NJR surgeon performance analysis on training

Since 2003, the NJR has collected and monitored data on hip and knee replacement procedures. It also now collects data on

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shoulder, elbow and ankle implants. Globally, it is the largest orthopaedic registry and analyses the performance of implants, surgeons and hospitals to help improve clinical practice and inform patients.

Initially, the NJR provided surgeons with just their Consultant in Charge (CiC) procedures. Since 2018, the NJR has reported outcome data for both CiC and Lead Surgeon (LS) procedures. A consultant can therefore determine if outcomes for all cases performed in their name, as CiC are similar to those where they are the LS and within the 'expected range'. Outcomes are presented through their standardised revision ratio (SRR) which is the ratio of observed revisions to expected revisions and is adjusted for age, sex, ASA grade and indication to account for case mix. The CLR illustrates SRR with funnel and thermometer plots (Figure 1). Generally, it would be expected that CiC and LS outcomes would be similar. However, there can be variation, particularly if the consultant is usually LS for the more challenging cases that the current discriminators are unable to completely control. The reverse is also possible where unsupervised cases are being performed in a consultant's name by a non-consultant lead surgeon. However, CiC outcome data remains the ultimate patient advocate. >>

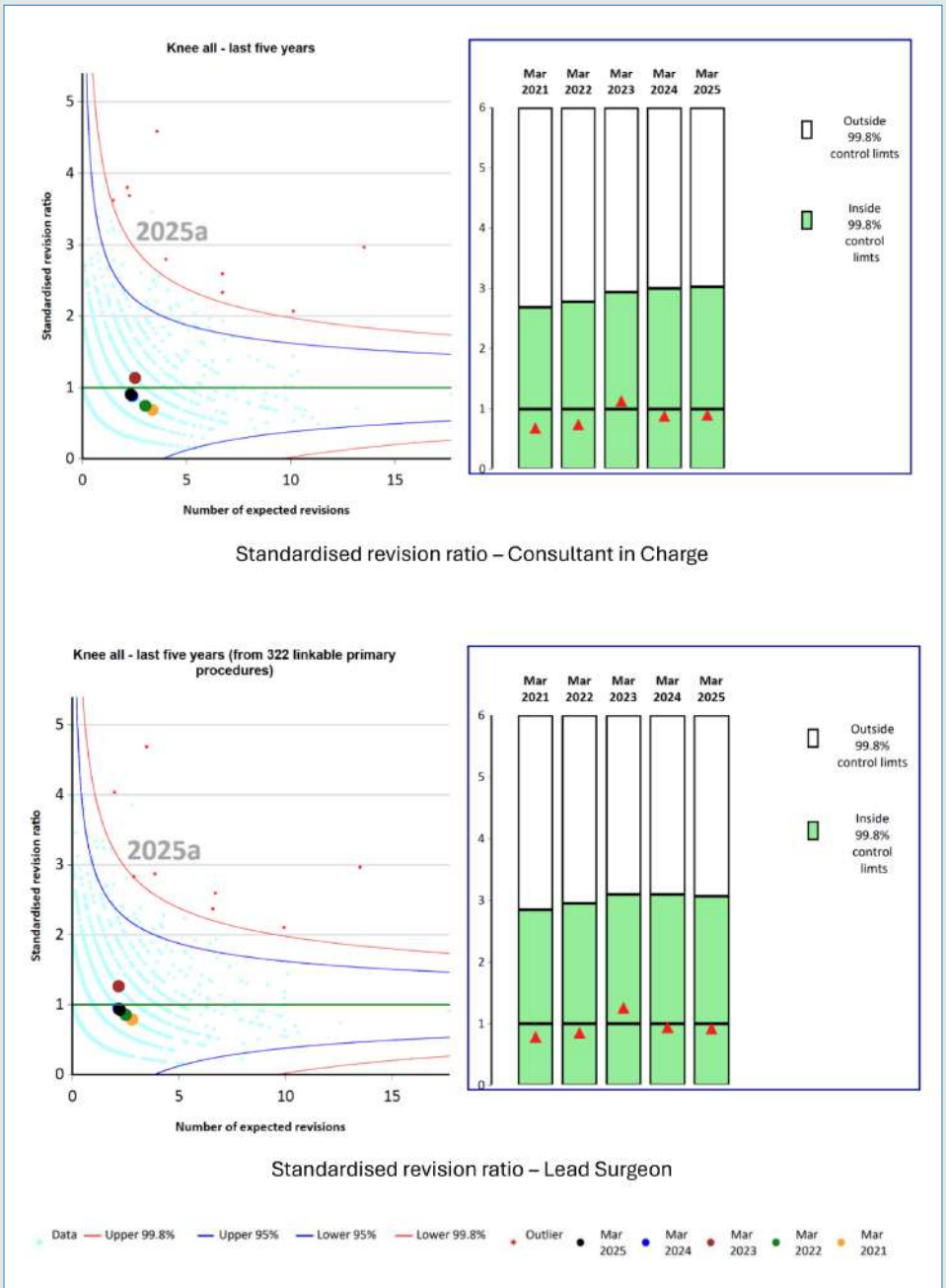

Figure 1: NJR funnel and thermometer plots demonstrating Standardised Revision Ratios by Consultant in Charge and Lead Surgeon.

Benchmarking surgeon performance in this manner has led to anxiety from consultant trainers about the effect of trainee-led procedures on their individual SRR. An unexpectedly high SRR can lead to outlier status via the alert (between 95% and 99.8% control limits) or alarm (crossing the 99.8% control limit) functions. The latter function triggers a review with the consultant's responsible officer, often their medical director, to evaluate their data and formulate a remedial action plan. Professional and reputational repercussions from being an outlier can foster negative attitudes towards training and whilst challenges remain in attributing outcomes between trainer and trainee, care must be taken to ensure data is used constructively. NJR performance analysis can be used to strengthen the feedback loop between outcomes and training and it should be used positively to foster a culture of safety, improvement and transparency.

Outcomes of trainee led hip and knee replacement surgery

Several studies have systematically evaluated and synthesised clinical outcomes associated with trainee-led hip and knee replacement surgery. Singh *et al*. conducted a meta-analysis comparing total hip replacement (THR) outcomes between trainees and consultants in over 40,000 cases in which nearly 90% of trainee-led procedures were supervised[1]. This study reported similar patient-reported functional outcomes and complication rates between the groups although operative time was longer by 13 minutes for trainees. Marder *et al*. performed a systematic review on the impact of surgical training in over 140,000 THR cases of which a third were trainee-led[2]. Although there was an increase in operative time by 15 minutes for trainees, comparable patient-reported functional outcomes, blood transfusion rates, complication rates and reoperation rates were seen between trainees and consultants.

Madanipour *et al*. found from a meta-analysis of over 90,000 total knee replacement (TKR) procedures, surgery performed by trainees was safe and effective with similar patient-reported functional outcomes, operative times and complication rates compared to consultants[3]. A combined meta-analysis capturing approximately 6,500 THRs, TKRs and unicompartmental knee replacement (UKR) procedures compared revision rates between trainees and consultants[4]. This study showed no significant difference in revision rates between the groups at 5-10 years follow-up. These reviews highlight that under supervision, trainee-performed hip and knee replacement surgery is safe and effective with comparable outcomes to consultants. Increased operative times associated with training are entirely expected but this does not appear to affect clinical outcomes.

Evidence from the National Joint Registry

With concerns raised by the potential effect of training on individual consultants' revision rates, it is imperative to review NJR data to determine if this perception is real or presumed. A series of large-scale observational studies utilising NJR data have examined the impact of surgeon grade on revision risk following hip and knee replacement surgery performed as primary procedures for osteoarthritis.

Fowler *et al*. analysed over 600,000 THRs of which trainees performed 10% of cases and reported no long-term difference in all-cause revision rates between consultant and trainees (Figure 2)[5]. However, their analysis did reveal an association between trainees operating

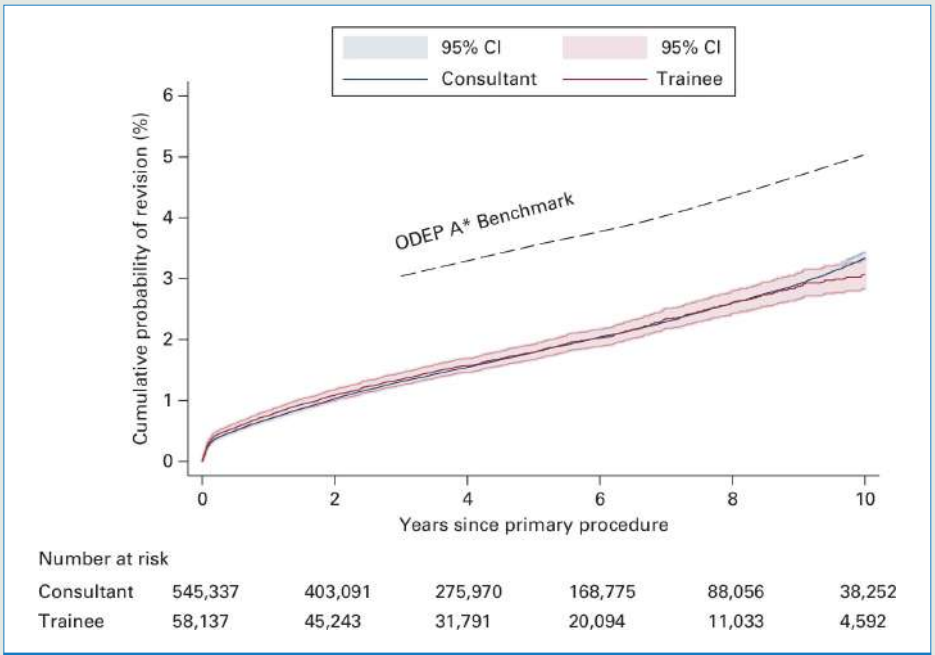

Figure 2: Kaplan-Meier survival analysis demonstrating no difference in cumulative probability of revision by surgeon grade for total hip replacement surgery (Reproduced with permission and copyright © of the British Editorial Society of Bone & Joint Surgery [Fowler TJ *et al.* The association between surgeon grade and risk of revision following total hip arthroplasty: an analysis of National Joint Registry data. *Bone Joint J.* 2022;104-B(3):341–351.

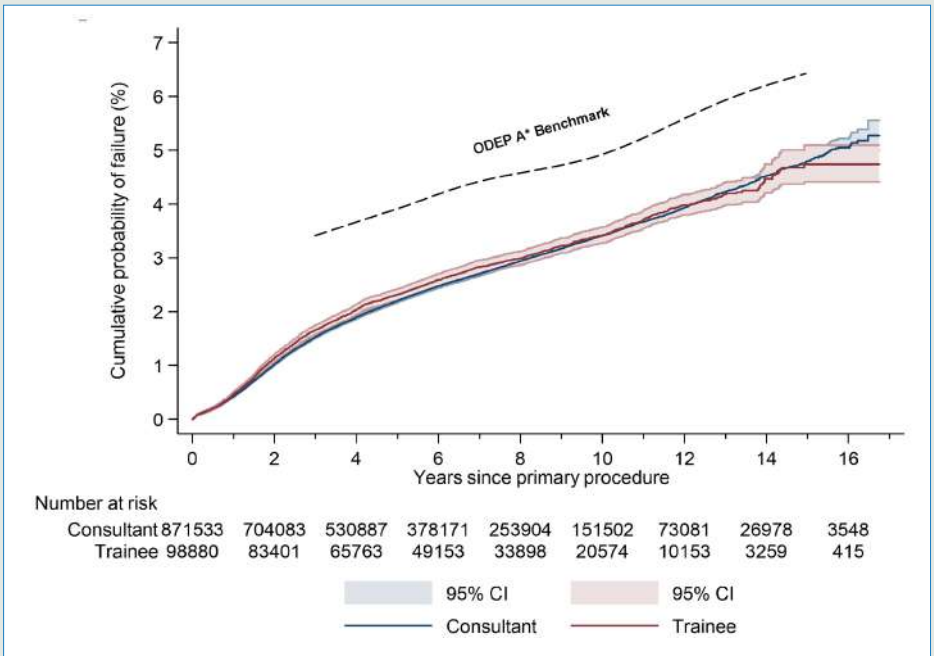

Figure 3: Kaplan-Meier survival analysis demonstrating no difference in cumulative probability of revision by surgeon grade for unicompartmental knee replacement (Reproduced from *PLOS One* as per Creative Commons Attribution license).

without scrubbed consultant supervision and an increased revision risk, most notably for postoperative dislocation. In a similar study, Fowler *et al*. evaluated over 950,000 TKRs of which 10% were trainee-led and again comparable outcomes in all-cause revision rates were observed between trainees and consultants (Figure 3)[6]. Unlike the THR cohort, there was no association between the level of supervision and the risk of all-cause revision. Further analyses revealed that trainee-led TKR may be associated with a small increased revision risk revision for aseptic loosening, infection and progression of patellofemoral arthritis up to four years after the procedure. This highlights the need for close supervision to ensure adequate cementation to prevent early loosening, procedural efficiency to reduce operative times and consideration of patellar resurfacing, even in training cases.

The same group also reviewed over 100,000 UKRs of which only 4% were trainee-led[7]. UKR is performed less commonly than TKR and is technically more demanding with a higher medium-to-long term revision risk. Fewer trainees are therefore exposed to UKR compared to THR and TKR during resident training. As expected, a higher revision rate was reported for UKR compared to THR and TKR but neither surgeon grade (Figure 4) nor level of supervision was associated with an increased revision risk. Most recently, Howgate *et al*. analysed nearly 10,000 knee replacements from a single NHS University Hospital over a 14-year period of which half were UKRs and 40% were trainee-led[8]. This large study revealed that the all-cause revision rate within one year of surgery was affected by neither lead surgeon grade nor level of supervision. Although these studies provide high-quality evidence supporting supervised surgical training they are limited by their observational nature and lack of functional outcome reporting.

As evidenced by NJR data, consultant trainers should be reassured that trainee-led THR, TKR and UKR surgery is safe and should not increase their short- and medium-term revision rates. As with any surgical procedure, close supervision is critical in maintaining successful outcomes.

Conclusion

Hip and knee replacement surgery forms a major component of the postgraduate orthopaedic syllabus and understanding their surgical principles is paramount for training in the generality of trauma and orthopaedic surgery. Several systematic reviews confirm that although trainee-led surgery takes longer, patient-reported functional outcomes and complication rates are comparable to consultant-led surgery. NJR data unequivocally supports supervised trainee-led THR, TKR and UKR surgery which does not lead to an increased risk of short- and medium-term revision. Concerns that individual consultant NJR performance analysis will be compromised by operative training are unfounded. Any misperceptions to the contrary will contribute to a cycle of negative training behaviour and will be responsible for denying residents vital training opportunities. These are the same opportunities that all consultants received in their own training and must dutifully be passed on to the next generation of surgeons. Resources for trainers should be made available to support operative training including planning of lists to allow increased operative times, access to suitable training cases and learning resources for trainers to develop their own educational practice. ■

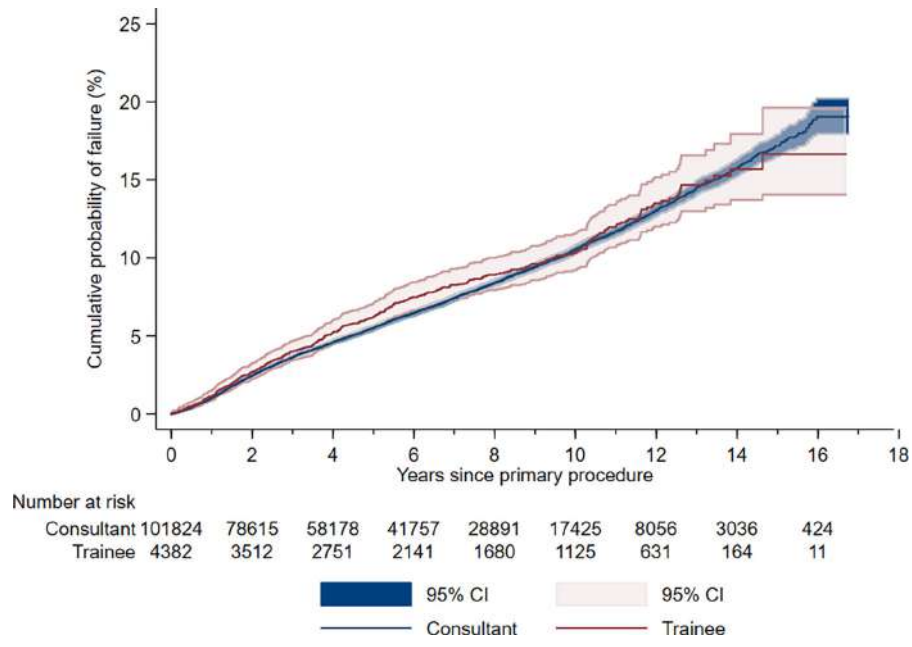

Figure 4: Kaplan-Meier survival analysis demonstrating no difference in cumulative probability of revision by surgeon grade for total knee replacement (Reproduced from *PLOS One* as per Creative Commons Attribution license).

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