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Viewpoint

The Economics of Revision Arthroplasty for Periprosthetic Joint Infection

Mackenzie A. Roof, MD, MBA, Vinay K. Aggarwal, MD, Ran Schwarzkopf, MD, MSc *

Department of Orthopedic Surgery, NYU Langone Health, New York, NY, USA

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Hip and knee arthritis is a prevalent and debilitating disease projected to affect over 78 million adults in the United States by 2040 [1]. Total hip arthroplasty (THA) and total knee arthroplasty (TKA) procedures provide definitive care for this life-altering pathology and allow patients to live their lives with reduced pain and increased function. Despite the efficacy of these interventions, it is important to recognize that revision THA (rTHA) and revision TKA (rTKA) procedures are also on the rise [2–4].

Revision procedures are more technically demanding and generally longer than primary THA (pTHA) and primary TKA (pTKA), as they often require removal of some or all components, irrigation and debridement, management of bone loss, and complex wound closures. Revisions for septic reasons may also require the placement of antibiotic spacers, multiple trips to the operating room for staged procedures, and prolonged intravenous antibiotic therapy. For these reasons, septic revisions pose an enormous financial burden on the healthcare system: Morcos et al. looked at 73 patients who underwent two-stage revision and found a higher overall cost with a mean cost of $35,500 for revision TKA performed for infection compared to $6800 for primary TKA [5]. The cost of a debridement, antibiotics, and implant retention (DAIR) procedure is estimated to be roughly $15,000, with initial procedure costs of $10,000 and failure-related additional treatment costs of $22,000 [6]. Given the complexity and cost, one may imagine that surgeons are compensated accordingly for the increased time and effort required to perform these cases; however, in practice, the complexity does not correlate with reimbursement rates [7,8]. Patel et al. examined the relationship between case difficulty and relative value units (RVU) compensation for rTHA and rTKA. When compared to the pTHA cohort, every revision type, except for modular component head/liner exchange, reimbursed less per minute, and every revision type reimbursed less per RVU [9]. For the TKA group, tibial component, all-component, and spacer revisions were reimbursed significantly less dollars per minute as compared to pTKA. Modular component/DAIR and all-component revisions had fewer dollars per RVU than primary TKA [7]. Quan et al. also had similar findings when comparing RVU per minute between aseptic and septic rTHA: aseptic rTHA cases were valued higher, at $9.28 per minute, whereas septic rTHA cases were valued at $7.65 per minute [8].

Numerous studies have investigated the efficacy of DAIR and two-stage exchange for the eradication of periprosthetic joint infection (PJI). More recent studies have shown eradication rates following DAIR ranging from 49% to 84% [10–20]. Two-stage exchange for both hip and knee PJI has been estimated to have a success rate ranging between 54% and 100% [21–28]. Studies directly comparing DAIR to two-stage exchange for the treatment of PJI have mixed outcomes: Zhang et al. showed a 70% success rate for DAIR compared to 75% in the two-stage group, although these differences did not reach statistical significance [29]; Barry et al. showed DAIR to be as effective as two-stage exchange for preventing reoperation for infection and more effective for maintaining function [30]; Leta's team compared DAIR, one-stage, and two-stage revisions and found a 19% (63/329), 13.9% (10/72), and 11.5% (28/243) re-revision rate for infection, respectively [12].

There are a few key factors inherent to rTHA and rTKA for infection that complicate these procedures when compared to DAIR. The 3 major factors are operative time, bone/soft tissue management, and unpredictability. DAIR procedures generally take 45-60 minutes, depending on how extensive a debridement is performed. Conversely, two-stage exchanges can often take

* Corresponding author. Department of Orthopedic Surgery, NYU Langone Health, 301 East 17th Street, New York, NY 10003, USA. Tel.: +1 212 598 6146.
E-mail address: schwarzk@gmail.com

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multiple hours for each procedure. Since the implants are removed, careful time and effort are required during the implant extraction to minimize bone loss, and many of these patients, during the secondary reconstruction, require the use of metal, cement, or bony augments to recreate an appropriate surface on which to fix the revision implants. When combined with the soft tissue loss and, when needed, consultations with plastic and vascular surgery to ensure appropriate soft tissue coverage and blood supply to the wound, the unpredictability of these procedures further increases.

The variable nature of rTKA and rTHA further affects the compensation of surgeons performing revision procedures. Feng et al. modeled dedicated rTHA and rTKA services (with 1 room to reflect the variability in case time and complexity, preventing a surgeon from using 2 operating rooms) compared with a two-room primary service. For hips, revision surgeons lost 26% potential RVU per day compared to one-room service and 55% potential RVU per day compared to two-room service [31]. Similar findings were demonstrated in the knee group [32] and in other recently published studies [33].

The current reimbursement model, as well as the foregone revenue from the pTHA and pTKA that could have been performed instead of a rTHA or rTKA, disincentivize revision surgeons from performing these complex procedures. Additionally, these same factors may prompt surgeons to preferentially perform DAIR as compared to one- or two-stage revisions, which are currently considered the gold standard for chronic hip and knee PJI [34]. This may potentially incentivize multiple washouts being performed prior to referral to a tertiary care center for a two-stage revision, which may cause delays in definitive care and infection eradication [12].

A few strategies should be considered to better align monetary incentives with the standard of care and make the patient care process more efficient. First would be to increase the RVU compensation for rTKA and rTHA. This will provide direct incentive to perform these surgeries, as surgeons would be appropriately compensated for their time, effort, and foregone RVUs from pTHA and pTKA. Second would be to develop dedicated revision team service lines whose sole focus within the hospital system is performing rTKA and rTHA. These teams would encompass a range of providers and would be led by the orthopaedic surgeon who would work closely with infectious disease physicians to guide antibiotic therapy. Protocolizing patient hospital stays, such as standardizing the placement of a peripherally inserted central catheter on postoperative day 1, can help streamline safe and efficient discharge. Third would be to regionalize the care of patients with PJI to institutions of excellence specializing in the management of PJI. OrthoCarolina's Periprosthetic Joint Infection Center and Duke University's Dedicated Orthopedic Infectious Disease Service have already started to institute this strategy and will serve as important case studies to understand the effect that regionalization can have on outcomes following rTKA and rTHA for PJI.

Conflicts of interest

V. Aggarwal is a paid consultant and has received research support from Zimmer. R. Schwarzkopf receives royalties and research support from Smith & Nephew, is a paid consultant from Zimmer, Intellijoint, and Smith & Nephew, receives stock options from Gauss Surgical, Intellijoint, and PSI, is an editorial board member of Arthroplasty Today and Journal of Arthroplasty, and is a board/committee member of American Academy of Orthopaedic Surgeons and American Association of Hip and Knee Surgeons; the other author declares no potential conflicts of interest.

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