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Complications - Infection

## Risk of Reinfection After Treatment of Infected Total Knee Arthroplasty



Adam R. Cochran, MD<sup>a</sup>, Kevin L. Ong, PhD<sup>b</sup>, Edmund Lau, MS<sup>c</sup>, Michael A. Mont, MD<sup>d</sup>, Arthur L. Malkani, MD<sup>e,\*</sup>

<sup>a</sup> Department of Orthopaedic Surgery, University of Louisville, Louisville, Kentucky

<sup>b</sup> Exponent, Inc, Philadelphia, Pennsylvania

<sup>c</sup> Exponent, Inc, Menlo Park, California

<sup>d</sup> Rubin Institute for Advanced Orthopedics, Baltimore, Maryland

<sup>e</sup> University of Louisville Adult Reconstruction Program, Louisville, Kentucky

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### ABSTRACT

**Background:** The purpose of this study was to determine the incidence of subsequent reinfections after initial treatment of an infected total knee arthroplasty, identify risk factors leading to reinfection, and compare results among the varying treatment modalities.

**Methods:** A total of 1,493,924 primary TKA patients were identified from the Medicare data between October 1, 2005, and December 31, 2011. Patients who encountered periprosthetic joint infection (PJI) after TKA were identified using International Classification of Diseases, Ninth Revision, Clinical Modification code 996.66. The risk of subsequent PJI was stratified based on the first-line treatment and compared between the various first-line treatment groups.

**Results:** A total of 16,622 patients (1.1%) were diagnosed with PJI. The Kaplan-Meier risk of PJI was 0.77% at 1 year and 1.58% at 6 years. Age ( $P < .001$ ), Charlson score ( $P < .001$ ), hospital control ( $P < .001$ ), race ( $P = .036$ ), census region ( $P = .031$ ), gender ( $P < .001$ ) were identified as risk factors for PJI. Of the PJI patients, 20.8% ( $n = 2806$ ) were treated with incision and drainage (I&D), 15.9% ( $n = 2150$ ) treated with I&D and liner exchange, 22.7% ( $n = 3069$ ) treated with 1-stage revision, 39.7% ( $n = 5364$ ) treated with 2-stage revision, and 0.98% ( $n = 132$ ) treated with amputation. After first-line treatment, 26% of patients with PJI had a subsequent PJI. Patients undergoing I&D as a first-line treatment had the highest risk of reinfection, with risks of 28.2% at 1 year and 43.2% at 6 years. One-stage revision patients had 33.9% greater adjusted risk of reinfection than 2-stage revision patients ( $P < .001$ ).

**Conclusion:** Two-stage reimplantation, despite 19% recurrence, had the highest success rate. Given the higher failure rates of I&D and single-stage revisions, guidelines need to be established for their specific indications.

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The number of total knee arthroplasties (TKAs) performed continues to increase, with approximately 719,000 procedures performed in the United States in 2010 compared to 326,000 procedures in 2001 [1,2] (<http://www.cdc.gov/nchs/data/ad/ad332.pdf>). The reason for this increase in number is multifactorial but may in

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\* Reprint requests: Arthur L. Malkani, MD, University of Louisville Adult Reconstruction Program, 550 S. Jackson Street, 1st Floor, ACB, Louisville, KY 40202.

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large part be due to a growing elderly population. The most common complication after TKA is prosthetic joint infection (PJI) which is a substantial source of morbidity and added costs to an already burdened health care system. The incidence of PJI after primary TKA in the United States is approximately 1.55% within 2 years and 0.46% thereafter [3]. Other series have identified an infection incidence of 1%–3% overall [4,5].

Treatment options for PJIs can be controversial and include irrigation and debridement with or without liner exchange, 1-stage reimplantation, 2-stage reimplantation, and amputation [6–12]. These options are based on multiple factors including the acuity of the infection, the virulence of the organism, and various patient-related factors. Acute infections (<4 weeks) have been treated

**Table 1**  
Procedure Codes for Treating PJIs.

| PJI Treatment           | ICD-9-CM Procedure Code   |
|-------------------------|---|
| I&D                     | 77.66, 77.67, 78.66, 78.67, 80.06, 80.16, 80.76, 80.86, 80.96, 83.3, 83.4, 86.04, 86.05, 86.22, 86.28 |
| I&D with liner exchange | I&D and 00.84 with no 81.55, 00.80-00.83  |
| One-stage revision      | 81.55 or 00.80-00.84  |
| Two-stage revision      | Stage 1 (84.56) followed by stage 2 (any of 84.57, 81.55, 00.80-00.84)                                |
| Amputation              | 84.10, 84.17  |

PJI, periprosthetic joint infection; I&D, incision and drainage.

with debridement, antibiotics, and implant retention with polyethylene liner exchange [6,11]. Subacute and chronic infections have been treated with 2-stage surgeries involving removal of the implants, antibiotic cement spacer placement, antibiotic therapy, and eventual revision surgery [10,12]. One-stage reimplantation has also been reported more commonly in Europe but is somewhat controversial and less often used in North America [13]. Despite various treatment options for PJIs, reinfections can still occur and pose a challenging problem [14]. The purpose of this study was to determine the incidence of subsequent reinfections after initial treatment of an infected TKA to evaluate temporal characteristics of this group, identify risk factors leading to reinfection, and compare results among the varying treatment modalities.

## Methods

Primary TKA patients were identified from the 100% Medicare Part A data from October 1, 2005, to December 31, 2011. This data set comprised inpatient claims records for all Medicare beneficiaries. International Classification of Diseases, Ninth Revision, Clinical Modification code (ICD-9-CM) code 81.54 was used to identify primary TKAs. Patients who encountered PJIs were identified using ICD-9-CM code 996.66. First-line treatment for PJI was determined based on the presence of ICD-9-CM procedure codes

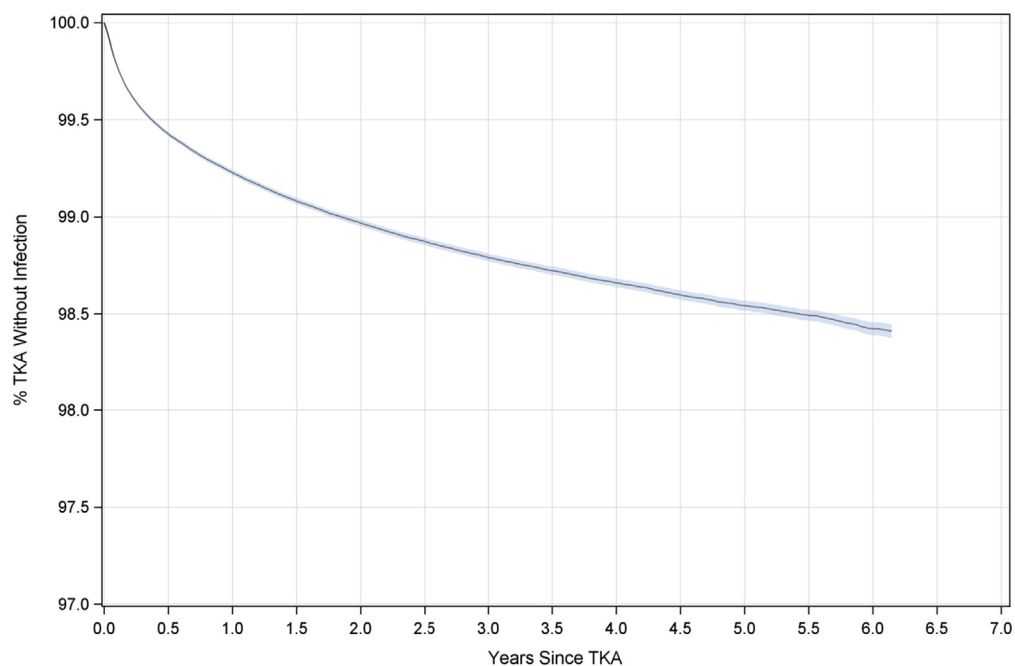
with the PJI diagnoses (Table 1). Infection patients were classified in the incision and drainage (I&D), I&D with liner exchange, 1-stage revision, 2-stage revision, and amputation groups.

The demographic characteristics of PJI patients were determined, along with the risk factors for PJI. These were evaluated using multivariate Cox regression with covariates of age, bed size, Charlson score, hospital control, race, census region, gender, state buy-in status, hospital teaching status, hospital location, and year. Hospital control was identified as nonprofit, private, or public, whereas hospital location was stratified into rural or urban locations. State buy-in status was used as a proxy for the patient's socioeconomic status, which indicates whether the patient's Medicare premium was subsidized by the state.

After the first-line treatment for PJI, the risk of subsequent PJI with treatment was determined. The second-line treatment was evaluated using the procedure codes identified in Table 1. The risk of subsequent PJI was stratified based on the first-line treatment and compared between the various first-line treatment groups using multivariate Cox regression.

## Results

Overall, 1,493,924 primary TKA patients were identified between October 1, 2005, and December 31, 2011. From this cohort, 1.1% ( $n = 16,622$ ) patients were diagnosed with PJI. Approximately, two-thirds of these infections were diagnosed within 1 year after primary TKA. The Kaplan-Meier risk of PJI was 0.77% at 1 year, 1.03% at 2 years, 1.21% at 3 years, 1.3% at 4 years, 1.5% at 5 years, and 1.6% at 6 years (Fig. 1). Based on the crude (unadjusted) demographics, it was observed that there was a relatively greater proportion of males, 65–69 years old, nonwhite patients, patients in the South, with state subsidy of the Medicare premium (buy-in status), with greater Charlson scores, and those operated at teaching hospitals and nonprofit hospitals for those diagnosed with PJI (Table 2). After adjusting for various demographic characteristics, age ( $P < .001$ ), Charlson score ( $P < .001$ ), hospital control ( $P < .001$ ), race ( $P = .036$ ), census region ( $P = .031$ ), gender ( $P < .001$ ), and state buy-in status



**Fig. 1.** Survival with infection as an end point after primary total knee arthroplasty (TKA).

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