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Original Article

Have Periprosthetic Hip Infection Rates Plateaued?

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ABSTRACT

Background: Periprosthetic joint infection (PJI) is a serious complication of total hip arthroplasty (THA). Although the number of revision cases is increasing, the prevalence of PJI as an indication for revision surgery, and the variability of this indication among surgeons and hospitals, is unclear.
Methods: The New York Statewide Planning and Research Cooperative System was used to identify 33,582 patients undergoing revision THA between 2000 and 2013. PJI was identified using International Classification of Diseases, Ninth Revision diagnosis codes. Volume was defined using mean number of revision THAs performed annually by each hospital and surgeon.
Results: PJI was the indication for 13.0% of all revision THAs. The percentage of revision THAs for PJI increased between years 2000 and 2007 (odds ratio [OR] = 1.05, $P < .001$), but decreased between years 2008 and 2013 (OR = 0.96, $P = .001$). Compared to medium-volume hospitals, the PJI burden at high-volume hospitals decreased during years 2000-2007 (OR = 0.58, $P < .001$) and 2008-2013 (OR = 0.57, $P < .001$). Compared to medium-volume surgeons, the PJI burden for high-volume surgeons increased during years 2000-2007 (OR = 1.39, $P < .001$), but did not differ during years 2008-2013 ($P = .618$).
Conclusion: The burden of PJI as an indication for revision THA may be plateauing. High-volume institutions have seen decreases in the percentage of revisions performed for PJI over the complete study duration. Specific surgeon may be associated with the plateauing in PJI rates as high-volume surgeons in 2008-2013 were no longer found to be at increased risk of PJI as an indication for revision THA.

Periprosthetic joint infection (PJI) following total hip arthroplasty (THA) is a serious complication that can lead to marked morbidity for patients and increased resource expenditure for payers and providers [1]. Postoperative PJI is a challenging complication, as it can be difficult to diagnose, has a variable time to presentation [2], and may require multiple medical and surgical interventions [3]. A recent study quantifying the burden of PJI vs aseptic mechanisms for revision THA found it to be the third most common reason for revision, with the longest length of stay and the second most expensive cost [4].

The frequency of revision THA is expected to double over the next decade [5], and the incidence of PJI may rise as well [6]. Although adverse outcomes of primary THA are inversely related to hospital and surgeon volume [7–9], PJI risks according to hospital and surgeon revision volume have not been well characterized. Therefore, in this study, we used a statewide database to evaluate (1) the rate of revision THA for PJI across all providers and (2) the rate of revision THA for PJI according to hospital and surgeon volume.

Materials and Methods

Database

The New York Statewide Planning and Research Cooperative System (SPARCS) is a healthcare data reporting system

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Investigation was performed at SUNY Downstate Medical Center in Brooklyn, NY.

Steven M. Kurtz and Michael A. Mont are Principal Investigators of this study.

This study was determined to be exempt from review by the institutional review board.

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Table 1
Patient Characteristics According to Time Cohort.

Variables	2000-2007			2008-2013		
	No PJI	PJI	*P*	No PJI	PJI	*P*
Age (mean, y)	67.2	66.9	.348	67.1	66.1	.002
Sex, %						
Male	41.4	49.0	<.001	42.8	49.9	<.001
Female	58.6	50.1		57.2	50.1	
Race, %						
White	85.9	81.8	<.001	83.6	78.1	<.001
Non-white	14.1	18.3		16.4	21.9	
Deyo category, %						
0	62.4	52.6	<.001	58.3	48.4	<.001
1	26.3	29.8		25.6	27.9	
≥2	11.4	17.6		16.1	23.7	
Insurance, %						
Government	60.1	64.1	<.001	57.9	60.0	.068
Private	39.9	35.9		42.1	40.0	

PJI, periprosthetic infection.

established by the New York State Department of Health (https://www.health.ny.gov/statistics/sparcs/) that collects data on all hospital admissions in New York State annually. Each patient record includes data on the demographics and clinical course, including medical diagnoses and surgical procedures. Because our version of the SPARCS database did not contain any protected health information, this study was determined to be exempt by our institutional review boards.

Cases

We initially identified the 33,582 admissions with an International Classification of Diseases, Ninth Revision (ICD-9) procedure code for revision THA (81.53, 00.70, 00.71, 00.72, 00.73, 80.05) between January 1, 2000, and December 31, 2013. We included hip explant (80.05) to capture the first stage of 2-stage procedures. PJI as an indication for revision THA was identified using ICD-9 diagnosis code 996.66, consistent with prior studies [4,10].

Covariates

We extracted demographic variables for each admission, including age (in years), sex (male or female), race (white or non-white), insurance (government or private/other), and year of admission. Comorbidities were assessed using the Deyo scoring method for ICD-9 coding [11], and this variable was evaluated categorically (0, 1, or ≥2 points; Table 1).

Volume

Hospital and surgeon volumes (low, medium, or high) were based on the mean annual number of revision THAs that were performed by each hospital and surgeon. An individual hospital or surgeon can be in more than one volume category over the course of the study duration depending on the number of revision cases performed each year. Because absolute volume cutoffs are not well defined in the literature, we divided hospital and surgeon revision volume into clinically sensible categories that also approximated a normal distribution of cases. Low-volume surgeons or hospitals performed a fewer number of cases than 1 standard deviation from the mean (16th percentile) whereas high-volume surgeons or hospitals performed a greater number of cases than 1 standard deviation from the mean (84th percentile). For hospitals, low volume was 1-10 revision cases per year, medium volume was 11-200 revision cases per year, and high volume was greater than 200 revision cases per year. For surgeons, low volume was 1-3 revision cases per year, medium volume was 4-30 cases per year, and high volume was greater than 30 cases per year (Table 2).

Table 2
Distribution According to Hospital and Surgeon Annual Procedure Volumes of Revision Total Hip Arthroplasties Performed From 2000 to 2013.

Hospital Volume	Surgeon Volume[a]			
	0-3	4-30	>30	Total
0-10	7.7%	8.1%	0.2%	16.0%
11-200	8.4%	48.9%	9.7%	67.0%
>200	0.3%	8.3%	8.4%	17.0%
Total	16.4%	65.3%	18.3%	100.0%

[a] Volume categories created assuming a normal distribution with boundaries for low and high volumes being at −1 and +1 standard deviations from mean volume.

Statistical Analysis

The burden of PJI as an indication for revision THA was expressed as the proportion of revision THAs with a diagnosis of PJI divided by the total number of revision THA cases. Hypothesizing that a nonlinear relationship may exist between PJI rate and year of surgery secondary to changes in risk factors for PJI as well as diagnosis and management of PJI, we used proc transreg to identify 2008 as an inflection point, which then stratified the study into subcohorts according to year of surgery (2000-2007 and 2008-2013).

To describe and compare the characteristics of patients undergoing revision THA according to year, we used frequency tables with Fisher exact tests for binary variables, frequency tables with chi-squared tests for categorical variables, and *t*-tests for continuous variables. Compared to all other causes of revision, patients undergoing revision THA for PJI during both time intervals were more likely to be male ($P < .001$), to be non-white ($P < .001$), and to have 2 or more comorbidities ($P < .001$). During 2000-2007, more patients undergoing revision for PJI had government insurance compared to those undergoing revision for all other causes. During 2008-2013, patients undergoing revision for PJI were more likely to be younger than patients undergoing revision for any other cause (Table 1).

We used multivariate-adjusted logistic regression models to calculate the odds ratio (OR) and 95% confidence interval (CI) of annual change in PJI rate over the complete study duration and time cohorts according to hospital and surgeon revision THA volumes. The PJI rate was calculated as the beta coefficient for the year variable in each multivariate-adjusted logistic regression model. In addition to adjusting for the patient demographic covariates, multivariate models included hospital and surgeon volume. The beta coefficients for each low and high revision volume strata were analyzed (medium volume as reference) to determine the additional association of hospital and surgeon volume on PJI rate.

We performed all statistical analyses using SAS version 9.4 (SAS Institute Inc, Cary, NC). Figures were generated using Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA). All *P* values were 2-tailed, and we used the Holm-Bonferroni method to correct for multiple comparisons.

Results

Rates of PJI

Periprosthetic infection was the indication in 13.0% of all revision hip arthroplasties during the study period, increasing from 10.9% in 2000 to 13.7% in 2013 (Fig. 1). Over the entire study period,