The Economic Impact of Periprosthetic Infections Following Total Knee Arthroplasty at a Specialized Tertiary-Care Center

Bhaveen H. Kapadia, MD [a], Mark J. McElroy, MS [a], Kimona Issa, MD [a], Aaron J. Johnson, MD [a],
Kevin J. Bozic, MD, MBA [b], Michael A. Mont, MD [a]

[a] Rubin Institute for Advanced Orthopedics Center for Joint Preservation and Replacement, Sinai Hospital of Baltimore, Baltimore, Maryland
[b] Department of Orthopaedic Surgery, University of California San Francisco, San Francisco, California

ARTICLE INFO

ABSTRACT

The purpose of this study was to measure the impact of periprosthetic joint infections (PJIs) on the length of hospitalization, readmissions, and the associated costs. Between 2007 and 2011, our prospectively collected infection database was reviewed to identify PJIs that occurred following primary total knee arthroplasty (TKA), which required a two-stage revision. We identified 21 consecutive patients and matched them to 21 non-infected patients who underwent uncomplicated primary TKA. The patients who had PJIs had significantly longer hospitalizations (5.3 vs. 3.0 days), more readmissions (3.6 vs. 0.1), and more clinic visits (6.5 vs. 1.3) when compared to the matched group, respectively. The mean annual cost was significantly higher in the infected cohort ($116,383; range, $44,416 to $269,914) when compared to the matched group ($28,249; range, $20,454 to $47,957). Periprosthetic infections following TKA represent a tremendous economic burden for tertiary-care centers and to patients.

Surgical site infections following total knee arthroplasty represent an increased risk of morbidity and mortality for the patient, as well as an increased economic burden for the entire healthcare system [1]. Currently, the incidence of post-operative surgical site infections following total knee arthroplasty ranges from 0.7% to 2.4% [2,3], which are often managed with two-stage revisions. It is estimated that the current cumulative annual cost of revisions for periprosthetic joint infections exceeds $566 million in the United States and is expected to exceed $1.6 billion by the year 2020 [2]. With projections that the number of total knee arthroplasty procedures, and the subsequent infection rate, are increasing each year, the projected cost of managing these surgical site infections is expected to increase as a problem for patients, physicians, and healthcare institutions [4].

It has been postulated that most of the costs incurred are due to frequent readmissions, prolonged hospital stays, prolonged use of analgesics and antibiotics, and extended post-operative rehabilitation periods, but further evidence-based information to support these metrics are necessary [5,6]. The annual estimated cost per infected total joint arthroplasty infection is approximately $100,000 [7,8], however, the mean cost of treating an infected total knee arthroplasty has been reported to be $6000 less than managing a hip infection [2]. Therefore, further studies are necessary looking specifically at

periprosthetic total knee arthroplasty infection to more accurately quantify their true economic impact.

Existing studies are limited because either the costs reported are estimates (and not actual costs), they offer no comparison group (such as non-infected primary total knee arthroplasty cases), or they report on a summation of all orthopaedic surgery cases rather than on individual procedures [3,9,10]. Additionally, many of these studies did not evaluate specifically what led to higher costs beyond multiple reoperations. Therefore, in the present study, we aimed to quantify the actual costs associated with a surgical site infection following total knee arthroplasty with a rigorous comparative analysis to patients who did not have an infection. Furthermore, we also measured the impact of periprosthetic infections on the length of hospitalization and the number of readmissions in comparison to patients who did not have an infection and underwent primary total knee arthroplasty.

Methods

This study was conducted at a specialized tertiary care center between January 1, 2007 and December 31, 2011. Patient medical records and an infection-tracking database were reviewed for 2857 patients undergoing total knee arthroplasty at our institution to identify periprosthetic infections occurring following primary total knee arthroplasty. Infections in the study were included only if they were deep infections, which were characterized as extending to the joint space or deep fascial layers. This was based on the definition set forth by the Musculoskeletal Infection Society [10]. A superficial infection following total knee arthroplasty, which was defined as only

involving the skin or subcutaneous tissue of the incision, was not considered periprosthetic infections for this study. Patients were monitored for 1 year from the initial operative date, based on the Centers for Disease Control and Prevention definition [11].

Once these patients were identified, we selected only those patients who had a deep or joint space infection and required a two-stage revision following their primary procedure. Our analysis allowed us to select 21 study patients to be in the cohort of periprosthetic knee infections. Institutional review board approval was obtained to analyze patient records and the data for the current study.

The study group was matched to group of 21 patients who had a primary total knee arthroplasty and did not have an infection for the following parameters: type of surgical procedure, date of surgery, surgeon, age, gender and the National Healthcare Safety Network risk category. A computer-generated algorithm was used to select these patients. Study patients were excluded from our analysis if a corresponding matched patient did not meet the parameters set forth above or if they did not have a minimum of 1-year follow-up data. Furthermore, in the event that there were more than 2 equivalent control patient candidates per study patient, individuals were chosen randomly using a randomization algorithm.

Hospitalization data were collected for each patient including the length of initial hospitalization for the primary procedure, the need for medical care within the 1-year follow-up period, the frequency of hospital and clinic visits, the length of each subsequent hospitalization, additional reoperations, and death during the follow-up period defined. There were no deaths in our study for either cohort.

Actual costs were obtained by reviewing hospital financial records for each individual case. The cost reports used in this study were those generated by the hospital financial system for services ordered during the patient's hospitalization. These charges, which were based on rates approved by the Health Services Cost Review Commission (HSCRC), but represent only those that were billed to the patient's insurance carrier (if insured) or to the patient (if uninsured). The total cost for each patient was based on the summation of each individual visit report generated. Each patient visit was verified by reviewing patient medical records and the corresponding charges were subsequently verified by consulting patient accounting and billing services.

These costs included fixed-direct medical costs (the costs consumed by all patients during clinic visits or hospitalization for any reason) and included: admitting and hospital bed per day charges. Variable-direct medical costs (the costs of services specific to patient consumption) included: pharmaceutical services, medical and surgical supplies, operating room services, laboratory costs, diagnostic and radiographic evaluations, blood products, consult services, anesthesia services and physical therapy. Charges for pharmaceutical services included those rendered during inpatient and outpatient services. Operating room service costs included charges for implants, intravenous solutions, surgical supplies, and post-operative recovery. Laboratory services included charges for chemistry, hematology, urology, immunology, microbiology, and processing histological samples. Radiology services included costs for X-rays, ultrasound,
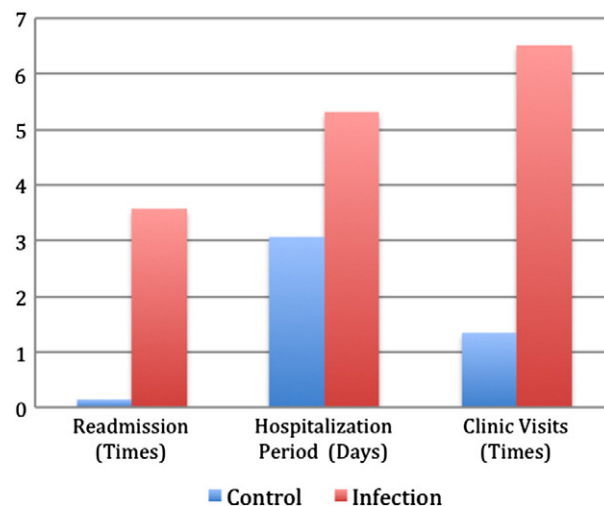

Fig. 1. Hospital and Clinic Visits.

computed tomography and magnetic resonance imaging scans. Physical therapy costs include charges for physical and occupational therapy evaluation and services. Consult service charges obtained in this study included cardiology, pulmonary, and emergency services obtained in an inpatient and outpatient setting.

Excel spreadsheet software (Version 2007, Microsoft Corporation, Redmond, Washington) was used for data collection, comparison, and calculations. GraphPad Prism software (Version 6.0 for Windows, GraphPad Software, San Diego, California) was used for statistical analysis. Chi-squared tests were used to compare the length of hospitalization, number of readmissions, and total cost differentials between the group of patients who had a periprosthetic knee infection and those who did not. A P value of less than 0.05 was used to determine statistical significance.

Results

The mean length of hospitalization in the group who had periprosthetic knee infection was 5.3 days (range, 2 to 27 days), which was significantly higher than 3.0 days (range, 2 to 6 days) in the matched group ($P = 0.0002$). Furthermore, the mean total number of days spent in the hospital within one year following primary total knee arthroplasty in the infected group was 24 days (range, 4 to 49 days), which was significantly higher than 3.43 days (range, 2 to 9 days) in patients who underwent a primary joint arthroplasty only ($P < 0.0001$).

Table 1
Hospital and Clinic Visits.

	Group		
	Infected Total Knee Arthroplasty	Primary Total Knee Arthroplasty	P Value
Number of Readmissions	3.57 (1 to 7)	0.14 (0 to 2)	P < 0.0001
Mean (range)			
Length of hospitalization	5.31 (2 to 27)	3.06 (2 to 6)	P = 0.0002
Mean (range) days			
Days in hospital	23.71 (4 to 49)	3.43 (2 to 9)	P < 0.0001
Mean (range) days			
Clinic visits	6.5 (2 to 12)	1.33 (1 to 2)	P < 0.0001
Mean (range)			

Table 2
Hospital Costs for Specific Services.

		Group		
		Infected Total Knee Arthroplasty	Primary Total Knee Arthroplasty	P Value
Cost ($) (mean)	Total Charges	116,382.65	28,249.57	P < 0.0001
	Hospital Bed	25,914.52	4931.62	P < 0.0001
	Operating Room Services	64,675.27	20,960.81	P < 0.0001
	Admission	544.16	151.24	P < 0.0001
	Pharmacy	9176.58	321.24	P = 0.0004
	Laboratory	3116.36	237.9	P < 0.0001
	Radiology	1284.96	75	P = 0.0012
	Anesthesia	1335.89	299.95	P < 0.0001
	Blood Products	1921.24	154.05	P < 0.0001
	Physical Therapy	3605.14	929.1	P < 0.0001
	Consults	377.24	1.05	P = 0.1350
	Clinic Visits	1469.5	217.67	P < 0.0001