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Temporal Relations of Unplanned Readmissions Following Total Knee Arthroplasty: A Study of Large State Inpatient Databases

Jared Braud, MD, Deepak Ramanathan, MBBS *, Alison Klika, MS, Suparna Navale, MS, MPH, Carlos Higuera, MD, Robert Molloy, MD

Department of Orthopaedic Surgery, Orthopaedic & Rheumatologic Institute, Cleveland Clinic, Cleveland, Ohio

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ABSTRACT

Background: Centers for Medicare & Medicaid Services stipulate a 90-day global period for hospitals for unplanned readmissions after primary total knee arthroplasty (TKA). However, not all readmissions are directly attributable to index surgery, and reasons for readmissions vary during this time period. This study identifies causes and temporal relations of readmissions using large state inpatient databases.

Methods: State inpatient databases of New York and California were queried for all primary TKAs performed from 2005 to 2011 and frequencies of all causes of unplanned readmission were identified from 0 to 90 days after index surgery using the *International Classification of Diseases, Ninth Revision*, codes. Temporal differences in proportions of readmission diagnoses were tested using the Pearson chi-square test.

Results: The query identified 419,805 cases of primary TKA from 2005 to 2011. There were 26,924 readmissions during the 90-day recovery period, with 15,547 (57.7%) at 0-30 days, 6593 (24.5%) at 31-60 days, and 4784 (17.8%) at 61-90 days. Primary diagnoses at readmission that were identified to be directly attributable to surgery comprised 38.3% readmissions at 0-30 days, 24.0% at 31-60 days, and 16.3% at 60-90 days. Proportion of readmissions directly attributable to surgery decreased over the 90-day period after index surgery.

Conclusion: From this analysis of 2 large state inpatient databases, primary diagnoses at readmission vary with time, and majority of these may not be directly attributable to index surgery or postoperative state up to 90 days. These findings suggest that the current 90-day global period policy for this procedure should be reformed to better reflect the profile of unplanned readmissions after TKA.

Total knee arthroplasty (TKA) has been proven to be a clinically and financially effective treatment for end-stage degenerative joint disease having failed nonoperative management [1,2]. Large annual volumes coupled with rapidly growing demand gives rise to substantial cost implications associated with TKA [3]. In 2004, 20% of all Medicare beneficiaries were hospitalized within 30 days of discharge at a price of 17.4 billion US dollars [4]. In that study, about two-thirds (62.9%) of Medicare fee-for-service beneficiaries who were discharged (67.1% after hospitalization for a medical condition and 51.5% after hospitalization for a surgical procedure) were readmitted or died within a year [4]. In 2005, the World Health Organization designated unplanned readmission as a key undesirable outcome [5]. Since this time, there has been a continued push toward improving value of health care in this field. Reasons for unplanned readmissions have been studied in an effort to decrease overall cost of total joint arthroplasty and readmissions have been used as a marker for quality of care.

Bundled payments are an alternative reimbursement model seeking to reduce cost using a prenegotiated payment arrangement for an episode of care. The Centers for Medicare & Medicaid Services (CMS) initiated reimbursement penalties for facilities with higher-than-average rates of unplanned readmissions in 2013. The Bundled Payment for Care Improvement was also launched in 2013. This is a voluntary bundled payment plan with 30-, 60-, and 90-day episodes of care. The Comprehensive Care for Joint Replacement

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* Reprint requests: Deepak Ramanathan, MBBS, Department of Orthopaedic Surgery, Orthopaedic & Rheumatologic Institute, Cleveland Clinic, Mail Code A40, 9500 Euclid Avenue, Cleveland, OH 44195.

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Initiative (CCJR) was built on Bundled Payment for Care Improvement and is a mandatory 90-day episode of care for total hip arthroplasty and TKA [6].

Current reported rates of readmission vary in the literature. Schairer et al [7] published unplanned readmission rates of 3.4% at 30 days and 6% at 90 days following primary TKA. The most frequent readmission diagnosis after TKA is surgical site infection [5]. Patients with pre-existing multiple comorbidities are at a higher risk for unplanned readmission within 90 days of surgery [5]. In a recent single-institution study, the overall 90-day readmission rate for both total hip arthroplasty and TKA was 7.8% and was most commonly related to infection and procedure-related complications [6]. In another recent study comparing readmission rates between different TKA implant designs, Jauregui et al [8] identified the National Surgical Quality Improvement Program 30-day readmission rate to be 4.3% of 12,035 surgeries. A registry-based review of 101,330 matched patients in England and Wales identified significantly a greater incidence of readmission for TKA compared with unicondylar knee arthroplasty [9]. However, trends in readmission diagnoses through the episode of care continuum have not been clearly defined, and what appropriately constitutes the surgical episode of care has been debated [7,10]. The purpose of the present study was to define the timing and causes (eg, surgery-related or medically related diagnosis) of unplanned readmissions following primary elective TKA, with the hypothesis that there will be no difference in the proportions of readmission diagnoses over time during the first 90 days postoperatively.

Methods

The Health Cost and Utilization Project (HCUP) state inpatient databases of both New York and California were queried for all primary TKA cases from 2005 to 2011 using the *International Classification of Diseases, Ninth Revision, (ICD-9)* Clinical Modification code 81.54. Primary identifiers were used to follow each patient and identify whether or not the patient was readmitted to the hospital as well as the diagnosis related to that readmission within 90 days of the surgery. Readmission diagnoses were subdivided into postoperative surgical diagnoses [7] and medical diagnoses (Appendix 1). Surgery related diagnoses were adapted following Schairer et al [7] and are shown in Appendix 1 (top). Medically related diagnoses were sorted by the standard *ICD-9* code groupings (Appendix 1, bottom).

The National Inpatient Sample is the largest publicly available all-payer inpatient health care database in the United States and is maintained by the HCUP. The State Inpatient Databases are available for individual analysis. For this study, California and New York states were chosen as 2 of the most populous states containing diverse patient populations and practice settings.

Data were analyzed for differences in proportions of readmission diagnosis over 3 time periods: 0-30, 31-60, and 61-90 days postoperative differences in proportions were tested for using the Pearson chi-square test. The predicted probability plots were generated via logistic regression, with time period treated as a 3-level independent variable and the proportion of readmissions due to each subspecialty or diagnosis group treated as the dependent variable. All analyses were performed using SAS 9.4 software (SAS Institute, Cary, NC). All testing were 2 sided and considered significant at the 5% level.

Results

A total of 419,805 primary TKAs were identified, with a total of 26,924 total readmissions within 90 days of discharge for a 90-day readmission rate of 6.41%. The trend decreased over the episode of care, with readmission rates of 3.7% (15,547 cases) in the first 30 days after surgery, 1.57% (6593 cases) for days 31 through 60, and 1.14% (4784 cases) for days 61 through 90 (Fig. 1).

The mean age at time or readmission was 67.2 years (±10.4). Men comprised 36.3% (152,190 of 419,805) and women comprised 62.2% (261,106 of 419,805) of the population (1.5%, 6509 of 419,805 patients had an undocumented gender). Medicare was designated as the payer in 56.9% (238,734 of 419,805) patients. Private insurance was listed as the payer in 33.9% (142,305 of 419,805), and the remaining were Medicaid, self-pay, or others. Caucasians comprised 72.8% (305,945 of 419,805) of the cohort. Disposition was made to a skilled nursing facility in 43.0% patients (178,798 of 419,805), home in 20.3% (85,001 of 419,805), and home health care in 36.4% (152,825 of 419,805). Blood transfusions were given in 26.2% patients (110,147 of 419,805). The remaining 73.8% (309,658 of 419,805) did not require transfusions.

There were 1126 different readmission diagnoses from 2005 to 2011 associated with the 26,924 readmissions. The most common readmission diagnoses for each of the 30-day time periods are listed in Table 1. The most frequent diagnosis during the first 30 days was the *ICD-9* code 99859: other postoperative infection. This code applies to abscess, wound infection, or postoperative septicemia. There were 1402 cases out of a total of 15,547 readmissions comprising 9.02% of the readmission diagnoses during this time period. This decreased to comprise 4.55% of the readmissions in the second 30 days and 1.99% of the readmissions during the final 30 days.

The results of the statistical analysis for the group of surgical diagnoses are summarized in Table 2. During the overall 90-day period, these diagnoses accounted for 30% of all the readmission diagnoses. During days 0-30, these diagnoses accounted for 38% of the readmission during this time period, and 22% of total readmissions. During days 31-60, these diagnoses accounted for 24% of the readmission during this time period and 5.8% of total readmissions. During the final period, days 61-90, these diagnoses accounted for 16.3% of the readmission during this time period and 2.8% of all readmissions. The proportion of readmissions for the surgical diagnoses achieved statistically significant difference in both the second and third 30-day periods ($P < .001$ and $P < .001$) showing a decrease from the expected proportions generated during the first 30 days (Fig. 2). This “predicted probability” plot is generated via logistic regression, with time period treated as a 3-level independent variable and the proportion of readmissions because of surgery-related diagnoses treated as the dependent variable.

The results of the statistical analysis for the nonsurgical diagnosis groups by *ICD-9* codes are summarized in Table 2. There were a number of *ICD-9* groups that showed a statistically significant ($P < .05$) increase from the expected proportions in both the second and third 30-day periods. These groups included

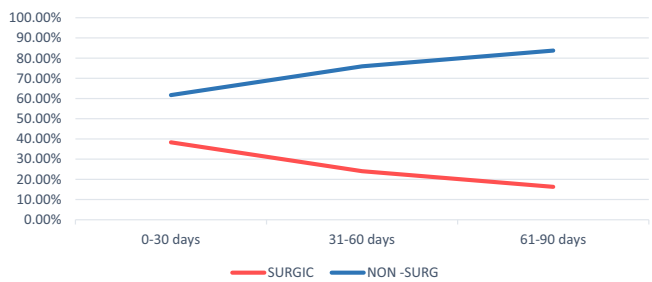

Fig. 1. Profile of readmissions over 90 days after primary total knee arthroplasty (TKA). Blue: not surgery related, red: surgery related.