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Dialysis Patients Undergoing Total Knee Arthroplasty Have Significantly Increased Odds of Perioperative Adverse Events Independent of Demographic and Comorbidity Factors

Taylor D. Ottesen, BS, Cheryl K. Zogg, MSPH, MHS, Monique S. Haynes, MPH, Rohil Malpani, BS, Kirthi S. Bellamkonda, MSc, Jonathan N. Grauer, MD *

Department of Orthopaedics and Rehabilitation, Yale School of Medicine, New Haven, Connecticut

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ABSTRACT

Background: The prevalence of dialysis-dependent patients is growing, and an increasing number of these patients are being considered for total knee arthroplasty (TKA). Studies assessing the preoperative risk associated with TKA in this population are limited to institutional cohorts with small sample sizes or national inpatient databases that lack follow-up data.

Methods: The 2006-2015 National Surgical Quality Improvement Program databases were queried for adult patients undergoing elective TKA. Differences in 30-day any/severe/minor adverse event, need for reoperation, readmission, and mortality were compared for dialysis-dependent and nondialysis TKA patients using risk-adjusted logistic regression. To account for the smaller number of dialysis patients and variations in study populations, coarsened exact matching was used. The proportion of adverse events that occurred before vs after discharge was also assessed.

Results: In total, 250 dialysis-dependent patients and 163,560 nondialysis patients met inclusion criteria. After controlling for patient demographics (age, sex, body mass index, functional status) and overall health (American Society of Anesthesiologists class), matched analysis revealed dialysis-dependent patients to be significantly more likely to experience any adverse event (odds ratio = 2.01; 95% confidence interval [CI], 1.34-3.02; $P = .001$), severe adverse event (odds ratio = 2.49; 95% CI, 1.61-3.84; $P < .001$), reoperation (odds ratio = 2.38; 95% CI, 1.19-4.75; $P = .014$), readmission (odds ratio = 2.32; 95% CI, 1.47-3.66; $P = .001$), and mortality (odds ratio = 6.71; 95% CI, 2.99-22.50; $P = .002$). The majority of adverse outcomes occurred postdischarge.

Conclusion: Independent of patient demographics and overall health (American Society of Anesthesiologists), patients undergoing dialysis before TKA are significantly more likely to experience 30-day adverse outcomes than matched nondialysis cohorts. Preoperative evaluation of bone health status and management of medical treatment are warranted in this fragile population. Cautious surgical planning, patient counseling, and heightened surveillance are necessitated throughout their perioperative period and postoperative recovery plans may need to be different from nondialysis counterparts. Furthermore, hospitals and physicians must take these increased risks into account when working on bundle payment reimbursement strategies and resource allocation.

Level of Evidence: 3.

Institutional Review Board: The study was deemed exempt from full review by the Human Investigation Committee at our institution.

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* Reprint requests: Jonathan N. Grauer, MD, Department of Orthopaedics and Rehabilitation, Yale University School of Medicine, 47 College Street, New Haven, CT 06511.

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In the United States, the prevalence of end-stage renal disease (ESRD) has been steadily increasing with over 120,000 new cases of ESRD being reported in 2014 alone [1]. Because dialysis is the major treatment modality for this disease, dialysis-dependent patient numbers have also continued to steadily climb. In 2013, incidence cases reached an all-time high of 113,944, an increase of 24% from incidence cases reported in 2000 [2]. Unfortunately, dialysis has been known to negatively affect bone health, with studies showing associations with osteoarthritis, fracture, and osteonecrosis [3,4]. Due to the growing number of dialysis patients and association with negative bone health, more dialysis-dependent patients are being considered for joint surgery such as total knee arthroplasty (TKA).

With the known frailty of dialysis-dependent patients, there is interest in studying TKA outcomes in this growing-compromised patient population [3–8]. However, even with increasing numbers of such patients, results of prior studies have varied greatly with reported incidence and severity of complications among dialysis-dependent patients such as in rates of mortality, infection, readmission, and revisions [3–8]. Furthermore, it is currently unknown whether the difference in outcomes of dialysis-dependent patients is due to decreased health and increased morbidity of this patient population or whether it is due to dialysis itself independent of other confounding factors.

The above-noted variation in results and inconclusive deductions may be connected to limitations of prior studies—namely small sample size and inpatient-only data. On the one hand, a number of studies examining outcomes of dialysis-dependent patients undergoing TKA have been limited to single-institution cohort studies. Patient samples among these studies range from 11 to 15 patients [4,9–11], which limit statistical power to detect potentially significant findings. On the other hand, other studies engineered to use larger patient population numbers have been limited to inpatient-only data collections such as the National Inpatient Sample (NIS) [3,6]. This means that any adverse events that occur after discharge would be missed by these studies. Furthermore, database studies based on administrative databases, like NIS, have also shown to have data accuracy issues [12].

In light of the above-noted limitations of institutional cohorts and lack of national database studies assessing outcomes beyond discharge for dialysis-dependent patients after TKA, the present study used the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database to address this knowledge gap. This dataset abstracts specifically defined preoperative, operative, and postoperative variables that are tracked for 30 days from the time of surgery.

The aim of the present study was to compare perioperative outcomes and complications of dialysis-dependent TKA patients relative to controls through logistical regression among matched samples (controlling for potentially confounding variables). By understanding the perioperative outcomes of TKA in this fragile, high-risk population, providers may be able to better assess the potential utility of this procedure, refine patient counseling guidelines, and assess a hospital system's clinical and financial resource allocation for the dialysis-dependent patient population undergoing this procedure [6].

Methods

Data Source and Study Cohort

This retrospective cohort study used data from patients undergoing elective TKA (Clinical Procedural Terminology code 27447) abstracted from the 2005-2015 ACS-NSQIP databases. NSQIP contains information on >150 demographic and clinical variables collected based on individual patient-level chart review [13]. Data are collected by trained clinical reviewers and participating hospitals across the United States through 30 postoperative days, regardless of discharge status.

In 2015, NSQIP contained information from more than 600 hospitals, including information on patient demographics, perioperative factors, and outcomes reported within 30 postoperative days. Inter-rater reliability for information abstraction for the database from patient records is reported to be >98% [13]. Patients with an International Classification of Diseases, 9th or 10th revision, code for infection, tumor, or trauma were excluded from analysis.

Abstracted information included age (categorized as <40, 40-49, 50-59, 60-69, 70-79, 80-89, and ≥90 years), sex, body mass index (BMI; categorized as <25, 25 to <30, 30 to <35, 35 to <40, and ≥40 kg/m^2), functional status (categorized as independent or partially/totally dependent), and American Society of Anesthesiologists (ASA) classification score. Dialysis dependence was defined by ACS-NSQIP as any patient who had received peritoneal dialysis, hemodialysis, hemofiltration, hemodiafiltration, or ultrafiltration within 2 weeks before their surgical procedure. This information must have been documented in the medical record to have been recorded affirmative. Complete cohort analysis was used to address all missing data; <5% of data was missing from all variables.

Perioperative Adverse Events and Secondary Outcome Measures

The occurrence of “any postoperative adverse event” (AAE) was the primary outcome measure. AAE included both severe adverse events (SAE) and minor adverse events (MAE) recorded within 30 postoperative days. More specifically, SAE included documentation of deep surgical site infection, sepsis, failure to wean from a ventilator within 48 hours, need for reintubation, renal failure, thromboembolic event (deep vein thrombosis/pulmonary embolism), cardiac arrest, myocardial infarction, and cerebrovascular accident (stroke). MAE included superficial surgical site infection, wound dehiscence, pneumonia, urinary tract infection, and postoperative renal insufficiency. Individual conditions were assessed combined and individually.

Additional secondary outcome measures included return to the operating room (OR), readmission (reported in ACS-NSQIP from 2011 onward), and mortality within 30 days. These were not included in the aggregated AAE, SAE, or MAE categories defined above.

The above-noted adverse outcomes were tracked for 30 days from the time of surgery. In comparing the date of adverse event to date of discharge, the adverse event could be determined to have occurred during the predischarge or postdischarge.

Statistical Analyses

Standard descriptive statistics, including chi-squared tests and unadjusted logistic regression, were used to compare differences in outcomes between dialysis-dependent and nondialysis-dependent patients. Risk-adjusted differences were compared using multivariable logistic regression, adjusting for underlying differences in categorical age, gender, BMI, functional status, and ASA class between patients receiving and not receiving hemodialysis. In order to address the relatively small number of patients receiving dialysis and to ensure the consistency of the reported multivariable logistic regression effects, risk-adjusted differences within coarsened exact matched (CEM) cohorts for each outcome were also assessed. Matching was conducted one to many based on the risk-adjustment covariates included above.

CEM is a matching technique that accounts for differences in potential known confounding variables by temporarily “coarsening” continuous variables (eg, age) into predetermined set width groups and matching patients based on the coarsened bins in