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# National Incidence of Reportable Quality Metrics in the Knee Arthroplasty Population

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ABSTRACT

*Background:* The Centers for Medicare and Medicaid Services (CMS) characterizes adverse quality events in the inpatient setting as patient safety indicators (PSI). The incidence of PSI has not been quantified in the total knee arthroplasty (TKA) population.
*Methods:* All patients in the Nationwide Inpatient Sample who underwent primary TKA during an inpatient episode in 2013 were identified using International Classification of Disease, Ninth Revision, Clinical Modification codes. The incidence of PSI was determined using the International Classification of Disease, Ninth Revision diagnosis code algorithms used by CMS. Multivariable logistic regression was used to determine significant associations between patient level covariates (demographics, comorbidities, and hospital characteristics) and the risk of experiencing one or more PSI after TKA.
*Results:* We identified 132,453 primary TKA patients in the Nationwide Inpatient Sample in 2013. We estimated the national incidence rate of experiencing one or more PSI as 0.98%. After adjusting for patient demographics and hospital characteristics, we found that relative to Medicaid/self-pay patients, neither Medicare nor privately insured patients faced significantly different risk of experiencing one or more PSI after TKA. However, alcohol abuse, deficiency anemia, congestive heart failure, coagulopathy, and electrolyte imbalance were associated with increased risk of experiencing one or more PSI after TKA.
*Conclusion:* The national incidence of PSI among TKA patients was lower than has been reported in other surgical populations. CMS uses the incidence of adverse quality events (measured using PSI) in part to determine hospital reimbursement. As value-based payment becomes more widely adopted in the United States, initiatives designed to eliminate and reduce PSI incidence can benefit vulnerable patient populations, physicians, and hospital systems.



As the population in the United States continues to age, the incidence and prevalence of total knee arthroplasty (TKA) is expected to increase substantially over the next two decades [1,2]. Simultaneously, the US healthcare system continues to transition toward coupling financial reimbursement to healthcare quality and patient safety. The Centers for Medicare and Medicaid Services (CMS) recently implemented the Hospital Acquired Conditions Reduction Program to connect healthcare reimbursement to healthcare quality and patient safety.

Through the Hospital Acquired Conditions Reduction Program, CMS can incentivize hospitals to improve healthcare quality by withholding Medicare reimbursements. CMS determines healthcare quality in part by calculating the incidence of surgically-relevant patient safety indicators (PSI), a quality of care metric developed by the Agency for Healthcare Research and Quality [3,4]. PSI are calculated using administrative billing data and enable standardized reporting of adverse healthcare quality events such as postoperative respiratory failure, postoperative hematoma, deep vein thrombosis (DVT), and pressure ulcer at the provider, hospital, and regional healthcare market levels [3]. CMS can withhold up to 1% of all Medicare reimbursements to healthcare providers or hospital systems that perform poorly according to PSI incidence [5].

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Despite the increasing incidence of TKA in the United States, the national incidence of PSI is unknown in this surgical population. Amid the transition toward relying on quality of care metrics such as PSI, it is important to establish a national benchmark of PSI incidence so that future progress in improving patient safety and care quality can be analyzed. Furthermore, it is important to determine demographic variables and comorbidities that should be incorporated into risk adjustment models for PSI incidence after TKA. For example, Browne et al [6] studied a large national sample of total joint arthroplasty patients and concluded that Medicaid patients had significantly poorer outcomes relative to other insurance cohorts. It is currently unknown if patient insurance status is associated with the risk of experiencing a PSI after TKA. The present study uses a nationally representative, all-payer database to (1) determine the national incidence of PSI among TKA patients and (2) quantify the association between patient demographics and hospital characteristics and the risk of experiencing one or more PSI after TKA.

## Materials and Methods

### *Overview and Study Design*

The present study used a retrospective cohort design. A nationally representative, all-payer database was used to determine the incidence of adverse patient safety events among TKA patients. A secondary analysis was conducted to determine which patient demographic, comorbidity, and hospital variables should be included in risk adjustment models that project PSI incidence after TKA.

### *Participants/Study Subjects*

In the primary analysis, Nationwide Inpatient Sample (NIS) data were queried to ascertain the total number of primary TKA procedures performed in 2013. We determined that a patient underwent primary TKA if the patient had International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code 81.54 listed during the inpatient episode [1,7,8]. This code includes unicompartmental, bicompartmental, and tricompartmental procedures. All patients aged 18 years and older who underwent primary TKA in 2013 were included in the primary analysis to determine the national incidence of PSI in this population.

In our secondary analysis, we quantified the significant associations between patient and hospital level variables and the risk of experiencing at least one PSI after TKA. We focused our analysis on comparing patients with private insurance with patients classified as Medicaid or self-pay to determine the association between primary insurance status and PSI incidence. Finally, we compared Medicare patients to Medicaid or self-pay patients undergoing primary TKA. We excluded patients with a primary payer status of “missing” or “other” from this secondary analysis.

### *Variables, Outcome Measures, Data Source, and Bias*

Data from the NIS from 2013 were used in the present study to obtain patient-level data on demographics, comorbidities, diagnoses, procedure performed, and hospital characteristics (eg, hospital size [as defined by the NIS], geographic location, hospital teaching status) [9].

The NIS is the largest all-payer inpatient database in the United States [9]. With data collected annually beginning in 1988, the NIS is a 20% stratified sample of all hospital discharges in the United States. Within the NIS, an individual entry corresponds to a single inpatient episode. Patient-level sampling weights are included in the NIS to enable the generation of national estimates. The NIS uses ICD-9 codes to define diagnoses, procedures, and in-hospital complications. Finally, the NIS includes Elixhauser comorbidity data composed of thirty specific comorbidities that have been shown to have a strong association with in-hospital mortality. The NIS includes 29 of the original 30 Elixhauser comorbidities [5].

### *Outcome of Interest*

In the primary analysis, national PSI incidence after TKA was the outcome of interest. The Agency for Healthcare Research and Quality and CMS publish a list of ICD-9 codes that indicate that a surgically relevant PSI occurred during an inpatient episode [10,11]. The surgically relevant PSI include pressure ulcer, iatrogenic pneumothorax, central venous catheter-related blood infection, postoperative hip fracture, perioperative hemorrhage or hematoma, postoperative metabolic derangement, postoperative respiratory failure, postoperative pulmonary embolism or DVT, postoperative sepsis, postoperative wound dehiscence, and accidental puncture or laceration. CMS combines these surgically-relevant PSI into a single PSI variable (termed PSI 90) to determine healthcare quality and patient safety. That is, if a patient experiences any one of the surgically relevant PSI that comprise the PSI 90 variable, then the numerator for PSI-90 incidence would increase. Although it is unclear if all the adverse events that comprise the PSI 90 measure are appropriate to measure adverse events after TKA, CMS uses this metric and it is therefore the outcome of interest in the present investigation.

In our secondary analysis, experiencing one or more PSI was the outcome of interest. We included a series of covariates in this analysis to assess whether they should be included in risk adjustment models that project PSI incidence. These covariates included patient insurance status (private insurance and Medicare relative to Medicaid/self-pay), demographic data (patient age, sex, race [black, Hispanic, Asian, Native American, and other, all relative to white]), hospital characteristics (academic hospital setting, admission status [elective vs nonelective], hospital bed size [medium and large, both relative to small], hospital region [South, West, and Midwest, all relative to Northeast]), length of hospital stay (LOS), and the 29 Elixhauser comorbidities included in the NIS. We chose these specific covariates because of their perceived clinical significance. Age was recorded and analyzed as a continuous variable.

### *Statistical Analysis*

In our primary analysis, the national incidence of PSI among TKA patients was determined using the sample weights provided in the NIS. In our secondary analysis, we ran a multivariable logistic regression model where experiencing one or more PSI during an inpatient episode served as our outcome variable, whereas insurance status, age, gender, race, Elixhauser comorbidities, hospital teaching status, hospital bed size, hospital region, LOS, and admission status served as covariates. An exchangeable working correlation was assumed and we adjusted for clustering of observations on hospitals by considering each hospital as a repeated factor. Given the large sample size of the NIS, our threshold for statistical significance was $P < .001$ [12].

Means, standard deviations, and frequencies for patient demographics, hospital characteristics, and PSI incidence were calculated. Continuous variables were compared across insurance groups using the independent $t$ test assuming unequal variance and categorical data were compared across insurance groups using the chi-squared test. The SAS statistical software package (version 9.4, SAS Institute Inc) was used for all analyses.