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Hospital Length of Stay following Primary Total Knee Arthroplasty: Data from the Nationwide Inpatient Sample Database

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ABSTRACT

Demand and cost of total knee arthroplasty (TKA) has increased significantly over the past decade resulting in decreased hospital length of stay (LOS) to counterbalance increasing cost of health care. The purpose of this study was to determine the factors that influence LOS following primary TKA. Discharge data from the 2009–2011 Nationwide Inpatient Sample were used. Patients included underwent primary TKA and were grouped based on LOS; 3 days or less, and 4 days or more. Majority of patients had a hospital LOS of 3 or less (74.8%). The most significant predictors of increased hospital LOS (≥4 days) were age ≥80 years, Hispanic race, Medicaid payer status, lower median household income, weekend admission, rural non-teaching hospital, discharge to another facility and any complication.

Total knee arthroplasty (TKA) remains one of the most successful surgeries in terms of cost-effectiveness, pain reduction and improvement in quality of life in patients suffering from end stage osteoarthritis (OA) of the knee [1]. The number of TKAs being performed each year is increasing and is expected to reach 3.48 million by the year 2030 [2]. An increased life expectancy of the population, the increasing prevalence of degenerative joint disease [3], and the increased demand for this successful procedure have all contributed to this rapid growth [2]. The result is an increased demand on hospital resources to provide adequate care to TKA patients, despite gradually increasing costs over the past several decades [4]. Measures designed to decrease hospital length of stay (LOS) following TKA have been implemented gradually and effectively in order to try and decrease cost of health care without compromising patients' health.

Older literature reported an average LOS of up to 23 days for a single total joint arthroplasty (TJA) [5] compared to current averages of 3.7 days [1,6]. There are several reasons for that dramatic decrease in LOS following TKA over the years. Improvement in medical management of patients has played an important role in improving patients' outcomes following TKA, as well as decreasing complication rates. Advances in surgical technique, pain management, anesthesia, deep vein thrombosis (DVT) prophylaxis and antibiotic prophylaxis have all benefited the health care system in decreasing inpatient LOS [7–9]. Technological advances in implant design and manufacturing have also played a role in providing patients with better implants that resulted in better patient outcomes, faster rehabilitation and shorter LOS [7,8]. Labor and implant costs have also increased over the past two decades [4], therefore hospitals are more and more eager to decrease the patients LOS to try to balance their cost-to-benefit ratio. Earlier and faster rehabilitation protocols have also become the standard of care, which allow patients to start their physical therapy immediately post-operatively with the goal of getting patients active and mobile at the earliest time possible [7,8]. Decreasing waiting time for patients seeking TKA has also been an incentive to maximize utilization of hospital resources and decreasing LOS [1,10].

The purpose of this study was to use a large national database in order to determine what variables affected inpatient LOS following primary TKA. Specifically the relationships between LOS, patient demographics, hospital demographics, inpatient complications, co-morbidities, weekend admissions and discharge destination were assessed. We hypothesize that several pre-operative and post-operative variables will be related to an increase in LOS after TKA, such as an increasing patient age and the presence of inpatient complications.

Materials and Methods

The data used were taken from the 2009–2011 discharge data of the Nationwide Inpatient Sample (NIS) [11,12]. Investigational review board approval was obtained by the Committee for Research Involving Human Subjects for this study. Data were accessed in January of 2014. The NIS database uses longitudinal hospital information from around 1000 hospitals in 40 states representing around 20% of the U.S.

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community hospitals containing 16 million inpatient stays and a large array of variables reported including patient demographics, hospital demographics, hospital LOS, diagnoses, procedures, co-morbidities, mortalities, and discharge destination [11]. At the time of analysis, the 2011 NIS database was the most current database available. The primary outcome of interest was LOS following primary TKA. Inclusion criteria for this study were inpatient stay for primary TKA using the International Classification of Diseases, Ninth Edition (ICD-9) code 81.54. All identifying patient information was removed prior to analysis. Patients were grouped into two groups in relation to hospital LOS: 3 days or less, and 4 days or more. These groups were chosen based on the most recent published averages of 3.7 days of hospital LOS [1,6].

The discharge weights included in the NIS were used to obtain weighted data for analysis. Use of the discharge weights allowed extrapolation of the NIS sample discharges to provide estimates for the whole nation. The weighted values presented in the NIS dataset were already rounded to the nearest whole number. Statistical analysis was done to determine the association between hospital LOS in patients undergoing primary TKA and patient demographics, hospital demographics, inpatient complications, co-morbidities, weekend or weekday admission and discharge destination. Table 1 displays the variables studied including age, sex, race, primary payer type, co-morbidities, Charlson co-morbidity index, mean household income quartile determined by patient zip code, hospital location and teaching status, weekend admission, inpatient complications and discharge destination. Obesity was determined as a body mass index above 30. Co-morbid conditions such as diabetes and obstructive sleep apnea (OSA) were determined based on subjective patient disclosure on admission. The Charlson co-morbidity index score is used to predict the ten-year mortality for a patient based on co-morbid conditions such as cancer, AIDS or heart disease (a total of 22 conditions). Each condition is assigned a score of 1, 2, 3 or 6 depending on the risk of mortality associated with this condition. Scores were divided into three groups; 0, 1 or 2, and equal or greater than 3 [13]. The patients 6 digit zip code was used to determine the median household income quartile.

The ICD-9 codes were used to group inpatient complications into 6 groups. Cardiovascular complications included ICD-9 codes for acute myocardial infarctions (ICD-9 Codes 410.00–410.92); cerebrovascular complications included ICD-9 codes for cerebral infarction (ICD-9 Codes 433.00–433.91); pulmonary complications included ICD-9 codes for pneumonia (ICD-9 Codes 480.00–486.00, 997.31–997.39), acute respiratory failure following trauma or surgery (ICD-9 Codes 518.51–518.53) and pulmonary embolus (ICD-9 Codes 415.11–415.19); mechanical wound complications included ICD-9 codes for surgical wound dehiscence and hematoma (ICD-9 Codes 998.12–998.13, 998.30–998.33); infection complications included ICD-9 codes for post-operative infection (ICD-9 Codes 998.51–998.59, 999.31–999.39, 996.66); systemic complications included ICD-9 codes for systemic shock (ICD-9 Codes 998.00–998.09, 998.11).

Table 1
Variables including in the study.

Independent Variables		
Age	**Co-morbidities**	**Hospital Type**
≤64	Diabetes	Rural
65–79	Obesity	Urban Non-Teaching
≥80	Obstructive Sleep Apnea	Urban Teaching
	Charlson Index Score	
Sex	0	**Weekend Admission**
Male	1 or 2	
Female	≥3	**Inpatient Complications**
		Cardiovascular
Race	**Median Household Income**	Cerebrovascular
White	≤$38,999	Pulmonary
Black	$39,000 to $47,999	Mechanical Wound
Hispanic	$48,000 to $62,999	Infection
Other	≥$63,000	Systemic
Payer Type	**Hospital Region**	**Hospital Length of Stay**
Medicare	Northeast	
Medicaid	Midwest	**Discharge Status**
Private	South	Home
All Others	West	Another Facility

Statistical Analysis

The chi-square test was used to determine significant differences between the two LOS groups. The primary analysis determined the pre-operative predictors of increasing hospital LOS using a logistic regression analysis with odds ratios (OR) and 95% confidence intervals (CI). The secondary analysis determined hospital LOS as it related to inpatient complications using a logistic regression analysis with odds ratios and 95% confidence intervals. All analysis was done on SAS version 9.2.

Source of Funding

No external source of funding was necessary for completion of this study.

Results

Total number of primary TKAs performed in the 2009–2011 period was 1,924,432. Majority of patients (74.8%) had a hospital LOS of 3 days or less. The hospital LOS after primary TKA for the pre-operative variables is listed in Fig. 1A and B. Increasing patient age was associated with an increased LOS with 33.3% of patients aged 80 years or older having LOS of 4 days or more. As compared to white race, a higher percentage of patients with Hispanic (31.7%) or black race (33.6%) had LOS of 4 or more days. A Medicaid payer status was associated with an increased hospital LOS with 35.2% staying 4 or more days in hospital compared to 20.7% for private payers (including HMO). Decreasing median household income was also associated with increased LOS. 50.7% of patients admitted on a weekend had LOS of 4 days or more compared to 25.2% of those admitted on a weekday. Rural hospitals had more patients with LOS of 4 days or more (27.7%) compared to urban non-teaching (24.0%) and urban teaching (25.9%) hospitals. Patients discharged to another facility stayed in hospital for 4 days or more (23.3%) compared to patients who were discharged home (20.0%). Fig. 2 depicts the relation between patient co-morbidities and LOS. Diabetes was associated with more patients staying 4 days or more in hospital (29.7%) compared to non-diabetic patients. Patients who sustained any type of complication had increased hospital length of stay as depicted in Fig. 3.

Odds ratio and 95% confidence intervals for the pre-operative variables are reported in Table 2. The most significant pre-operative variables associated with an increase in hospital LOS were age ≥80 (OR 1.75, CI [1.73–1.77]), Hispanic (OR 1.44, CI [1.42–1.46]) and black races (OR 1.57, CI [1.55–1.59]), Medicaid payer type (OR 2.07, CI [2.04–2.11]), median household income ≤$38,999 (OR 1.34, CI [1.33–1.36]), rural hospital type (OR 1.10, CI [1.08–1.11]), weekend admission (OR 3.05, CI [2.87–3.23]) and discharge to another facility (OR 1.88, CI [1.87–1.89]). Odds ratio and 95% confidence intervals for inpatient complications are reported in Table 3. All six complication categories were associated with increase in hospital LOS, the most significant of those being cardiovascular (OR 15.11, CI [13.91–16.43]), pulmonary (OR 10.40, CI [10.07–10.73]), infection (OR 10.25 [9.48–11.08]) and mechanical wound complications (OR 10.37, CI [9.75–11.03]).

Discussion

Multiple pre-operative variables and post-operative inpatient complications were identified that contributed to a statistically significant increase in hospital LOS after primary TKA. Older patients (age ≥ 80 years) were found to be more likely to have LOS of ≥4 days compared to younger patients (age ≤ 64 years). Patients 65 to 79 years old were also more likely to have LOS ≥ 4 days compared to patients