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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.

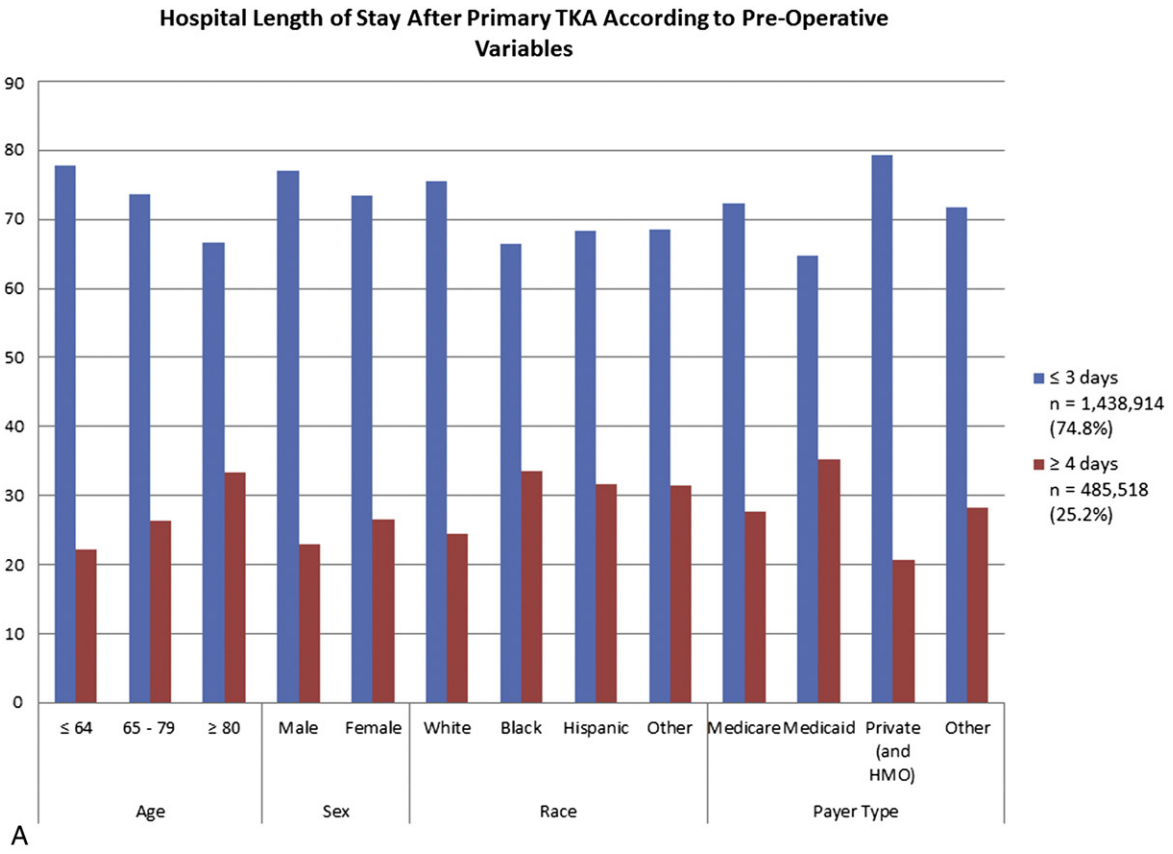
Results

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



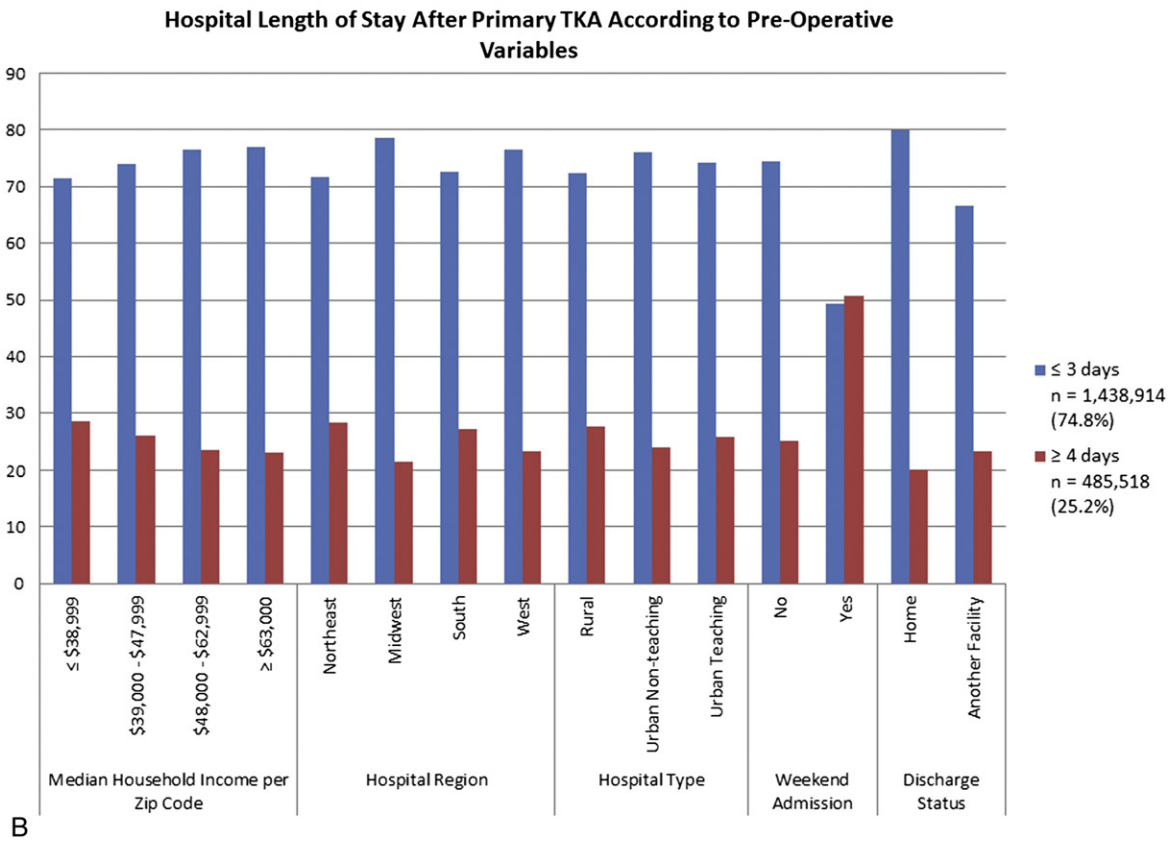


Fig. 1. A and B: Showing clustered column graphs of the association between pre-operative variables and hospital length of stay following primary total knee arthroplasty.

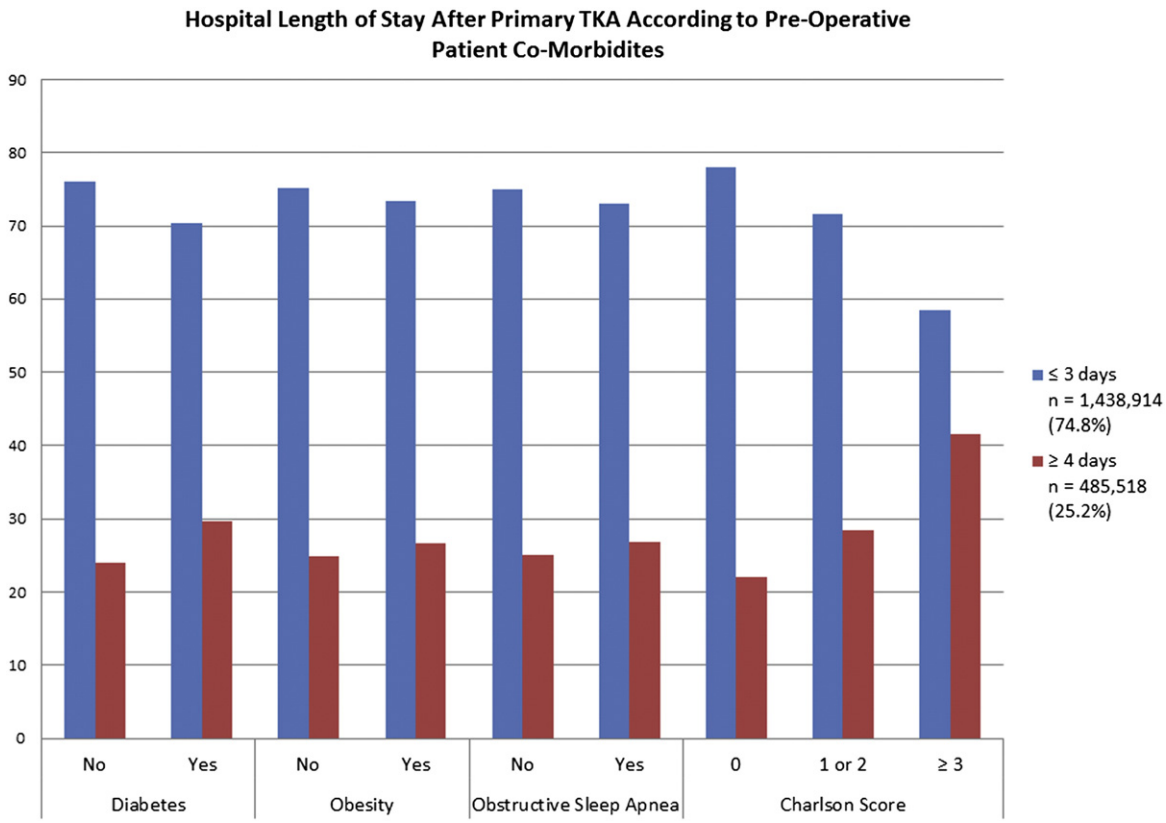


Fig. 2. Showing the clustered column graph of the association between pre-operative patient co-morbidities and hospital length of stay following primary total knee arthroplasty.

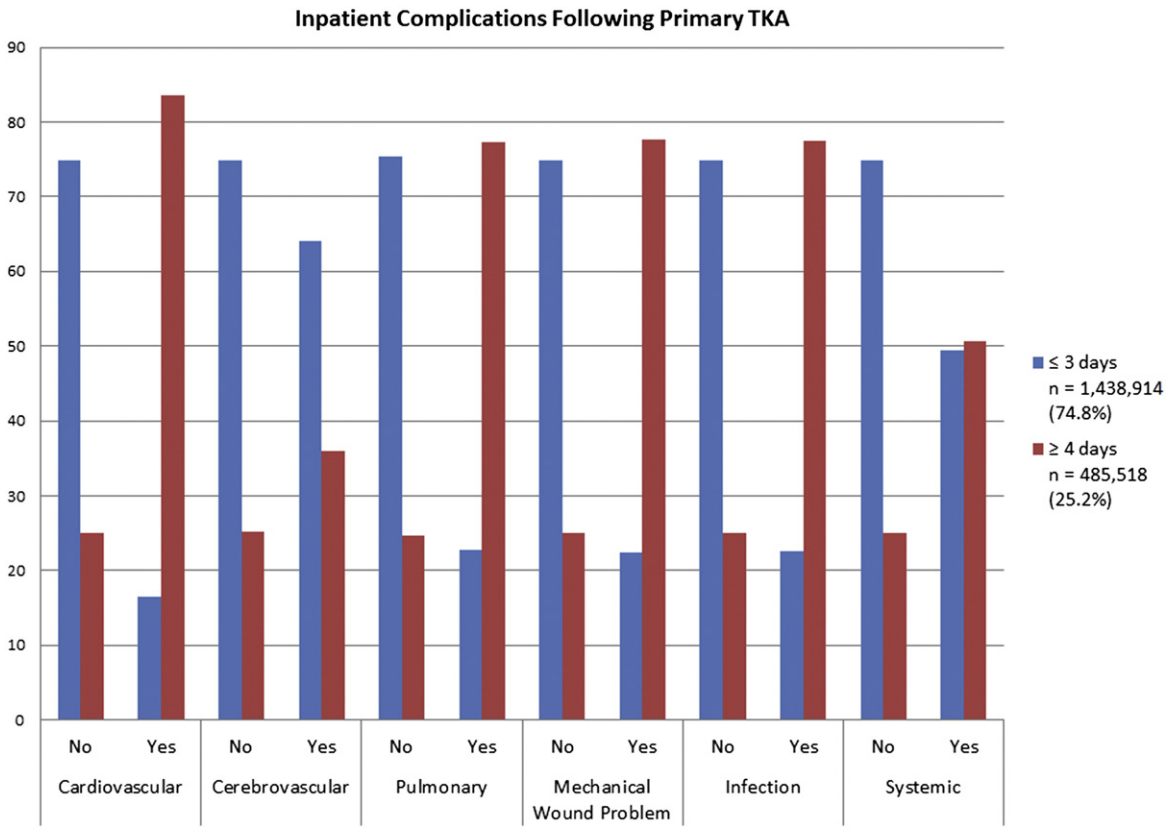


Fig. 3. Showing the clustered column graph of inpatient complications following primary total knee arthroplasty.

Table 2
Odds ratio and 95% confidence intervals for the pre-operative variables.

Variables	Odds Ratio for ≥4 vs ≤3 days (95% CI)
Age (Compared to ≤64)	
65–79	1.26 (1.25–1.27)
≥80	1.75 (1.73–1.77)
Female (Compared to Male)	1.22 (1.21–1.22)
Race (Compared to White)	
Black	1.57 (1.55–1.59)
Hispanic	1.44 (1.42–1.46)
Other	1.43 (1.40–1.45)
Payer Type (Compared to Private/HMO)	
Medicaid	2.07 (2.04–2.11)
Medicare	1.47 (1.46–1.48)
Other	1.51 (1.48–1.53)
Diabetes	1.33 (1.32–1.34)
Obesity	1.10 (1.09–1.11)
Obstructive Sleep Apnea	1.10 (1.09–1.11)
Charlson Score (Compared to Score of 0)	
1 or 2	1.41 (1.40–1.42)
≥3	2.52 (2.49–2.56)
Income Quartile (Compared to ≥$63,000)	
≤$38,999	1.34 (1.33–1.36)
$39,000–$47,999	1.18 (1.16–1.19)
$48,000–$62,999	1.03 (1.02–1.04)
Hospital Region (Compared to West)	
Midwest	0.90 (0.89–0.91)
Northeast	1.29 (1.28–1.31)
South	1.24 (1.22–1.25)
Hospital Type (Compare to Urban Teaching)	
Urban Non-Teaching	0.90 (0.89–0.91)
Rural	1.10 (1.08–1.11)
Weekend Admission	3.05 (2.87–3.23)
Discharge to Other Facility (Compared to Home)	1.88 (1.87–1.89)

aged ≤64 years but not to the extent of patients aged 80 years or more. Recent advances in medical management and the faster rehabilitation processes have allowed orthopedic surgeons to offer TKAs to older more complex patients [1,10]. However, even with the presence of improving medical care, some older patients are more medically complex requiring longer hospital stays for medical optimization prior to discharge. Older patients might also be slower in rehabilitating following major surgeries, which results in an extended hospital stay to allow them to become more mobile and ambulatory before being safely discharged [14].

Patients who have Hispanic or black race were more likely to have LOS of ≥4 days compared to patients with white race. Lavernia et al reported on the influence of racial and ethnical factors on post-operative outcomes after TKA. They found that patients from racial and ethnic minorities, had worse patient-perceived outcomes in terms of pain relief and function compared to whites [15]. Another study by the same group concluded that black patients undergoing TKA had lower scores than whites in most outcome measures including the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Quality of Well Being, Short Form-36, and Pain and Anxiety Symptoms Scale (PASS), regardless of the follow-up period [16]. Kamath et al found in their study significantly worse Knee Society Scores (KSS) and knee range of motion (ROM) in African-American females in particular [17].

Table 3
Odds ratio and 95% confidence intervals for inpatient complications.

Inpatient Complication	Odds Ratio for ≥4 vs ≤3 days (95% CI)
Cardiovascular	15.11 (13.91–16.43)
Cerebrovascular	1.67 (1.60–1.75)
Pulmonary	10.40 (10.07–10.73)
Mechanical Wound	10.37 (9.75–11.03)
Infection	10.25 (9.48–11.08)
Systemic	3.06 (2.92–3.20)

Patients who are still in pain and are not functioning well after surgery are usually kept in hospital until they are fit enough to be sent home, providing a possible explanation for the longer LOS in patients with Hispanic or black race.

We hypothesized that Medicare patient would be more likely to have an increased LOS when compared to all other payer types, given that the majority of Medicare patient are aged 65 years or more. However, our results contradict our hypothesis. When comparing payer types to private patients, Medicaid patients were more likely to have hospital LOS of ≥4 compared to Medicare patients. Medicaid provides health insurance for more than one fifth of the U.S. population — 73 million low-income people in 2012 [18]. Medicaid recipients must be U.S. citizens or legal permanent residents, and may include low-income adults, their children, and people with certain disabilities. Medicaid patients often have complicated behavioral health, transportation, and social service needs that require physician and staff time [19]. One explanation might be that patients on Medicaid, although younger than patients on Medicare, might be more medically complicated with more comorbid conditions that need more attention and management, which might result in them staying in hospital for a longer period of time.

Patients living in homes with lower median incomes (≤$38,999) were more likely to have LOS of ≥4 days compared to patients living in homes with higher median household income (≥$63,000). Patients living in homes with lower median incomes tend to delay treatment due to their financial restrictions and cost of undergoing TKA. A delay in diagnosis and treatment of end stage OA may result in a more severe disease process with larger deformities, which results in a more complicated surgery. In addition, patients who delay medical attention for orthopedics concerns may be more likely to delay other areas of their health care and are more likely to present with increased co-morbidities. Therefore, they might necessitate longer hospital stays in order to manage their co-morbidities and medically optimize before sending them home for rehabilitation. Losina et al published their findings on use of hospitals with worse outcomes following TKA by patients from vulnerable populations. They reported that patients that are poor, non-whites and non-urban tended to seek care in hospitals with low volumes and worse outcomes, and this puts them at higher risk for peri-operative complications and increased hospital LOS [20].

Another interesting finding in this study was that patients admitted to a rural non-teaching hospital were more likely to have a hospital LOS of ≥4 days compared to urban teaching hospitals. Katz et al reported on the association between hospital and surgeon procedure volume and the outcomes after TKA. They found lower peri-operative complications and hospital LOS following TKA in patients managed at hospitals and by surgeons with greater volumes of TKA [21]. Another study by Cram et al reported that specialty hospitals had higher volumes of TKA, better patient outcomes, and less complication compared to general hospitals [22]. One can argue that specialty hospitals are mostly urban non-teaching hospitals that tend toward decreasing hospital LOS to increase their overall profit from having a high volume specialized center of care.

Patients admitted on a weekend were more likely to have a hospital LOS of ≥4 days compared to weekday admissions. This observation might be due to the fact that some patients scheduled for an elective primary TKA are admitted on a weekend to allow for their medical optimization before undergoing surgery. In general, the trend is to admit the patient to the hospital on the day of surgery, so basically the total hospital LOS almost equals their post-operative hospital LOS. When patients are admitted a few days before undergoing TKA, these days count toward their overall hospital LOS even though their post-operative LOS might be similar to the national average. Patients who were discharged to another facility were more likely to have a hospital LOS ≥4 days compared to patients who were discharged home. Patients who are discharged to a skilled facility for extended care are not medically optimized to go home, but are healthy enough to be sent to another facility. Therefore, these patients might need a few extra days of stay

in hospital to bring their activity to a sufficient level to warrant discharge to another facility. Another possibility for increased LOS before discharge to a skilled facility is the logistics involved for coordinating patient transfer. Patients that are sent to other facilities tend to be older patients with comorbidities who are not fit enough to be sent home [23].

Patients who sustained inpatient complications were more likely to have a hospital LOS of ≥4 days compared to patients with no complications (Table 3). The most significant of those complications were cardiovascular, pulmonary, infection, and mechanical wound complications. These finding were consistent with findings in the literature [24–29]. Patients who suffer from complications following TKA need medical workup and management, which increases cost and utilization of resources, in addition to increasing their hospital LOS. Therefore, every effort should be done to optimize the patient's medical co-morbidities in order to have more favorable outcomes following TKA and decrease post-operative complications as well as hospital LOS. These measures would potentially decrease the overall cost and burden on the patient as well as the health care system.

This study is not without limitations. First, this study uses a large national database that only looks at hospital inpatient stays by ICD-9 codes. For this reason patients are not able to be followed longitudinally, and the data provided are only a snap shot of that given hospital visit.

Limitations of this study are related to the choice of and the accuracy of information of the database. However, the database undergoes periodic quality checks with internal and external validation regarding this key feature of NIS database. The number of days spent in hospital was determined by subtracting the admission day from the discharge day without taking into account the number or hours spent in hospital. For example, a patient admitted on the 15th at 11 pm and discharged on the 16th at 3 am would have spent 1 day in hospital while in fact he only spent 4 hours. Another limitation was that the data retrieved only contained information about the inpatient LOS without any notion about readmission rates following primary TKA. The introduction of the Medicare prospective payment system in 1983 provided hospitals with an incentive to control their costs [30,31]. One way to decrease cost is to decrease the patients' hospital LOS and maximize utilization of resources available [1]. However, there is a concern that hospitals may be reducing the patients' hospital LOS by discharging patients early during their rehabilitation process [32], which results in increasing the utilization of extended-care facilities, and possibly increasing readmission rates of these patients that suffer from complications. Bini et al reported on the 90-day readmission rate following discharge to other facilities as opposed to discharge home [33] and found that patients discharged to another facility had significantly higher readmission rates than those sent home. This process might negate all the efforts of cost saving related to decreasing hospital LOS [1]. Another limitation was that this database failed to specify the reason for the weekend admissions for primary TKA. Patients admitted on a weekend might undergo their TKA during a weekday, with the days spent in hospital pre-operatively considered part of the global hospital LOS. One solution for that confounding variable is to differentiate between post-operative hospital LOS and global hospital LOS which occasionally are different and can alter the interpretation of the results.

Conclusion

Multiple variables were associated with increased hospital LOS following primary TKA including 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. The demand on TKA is ever increasing due to the well proven clinical success of this procedure and the increasing population age. It is important to recognize all the factors that affect hospital LOS to try to maximize the use of medical resources, optimize hospital LOS and ultimately optimize the care of our patients.

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