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The Financial Impact of a Multidisciplinary Preoperative Risk Stratification Program for Joint Arthroplasty

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ABSTRACT

This study's purpose was to assess the impact of a preoperative risk stratification program on joint arthroplasty outcomes at a single institution. We hypothesized that by using a standardized preoperative risk stratification center we would see better outcomes and decreased costs. The triage cohort (T) included 1498 patients assessed at a standardized risk stratification center, and the non-triage cohort (NT) included 1100 patients who did not utilize the center. The T cohort had significantly higher ASA classification ($P<0.0001$) and ACCI scores ($P=0.028$). We found no significant difference in complication rates. The T cohort showed a significant decrease in LOS ($P<0.0001$) and an increase in average reimbursement ($P=0.009$). A standardized preoperative risk stratification center can contribute to decreased LOS, increased reimbursement and help prevent complications.

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) have repeatedly been found to be clinically effective interventions for reducing arthritic pain, improving function, and improving quality of life in patients with disabling arthritis of the hip and knee [1,2]. However, clinical outcomes and cost effectiveness can vary depending on factors such as patient co-morbidities, and hospital standardization of care [3].

According to the Nationwide Inpatient Sample survey, a total of 332,000 primary THAs and 719,000 primary TKAs were performed in the United States in 2010 [4]. The American Joint Replacement Registry data from 2013 reports a total joint arthroplasty revision rate of 6.6% overall with 3.4% made up of hip revisions, and 3.1% made up of knee revisions [5]. Population projections performed by Kurtz et al estimate that the demand for primary THAs will grow by 174% from 208,600 procedures in 2005 to 572,000 procedures in 2030. They estimate that primary total TKAs will grow by 673% from 450,000 procedures in 2005 to 3.48 million procedures in 2030 [6]. Likewise, total hip and knee revisions are expected to grow by 137% and 601% respectively by 2030 [6]. Co-morbidities such as hypertension, diabetes mellitus, and obesity are continuously increasing in the US along with the increasing population of elderly patients, many of whom also suffer from debilitating hip and knee arthritis. Therefore, surgeons will need to account for these and other co-morbidities especially when planning elective procedures such as THAs and TKAs.

Complications following hip or knee arthroplasty can occur in any patient. However specific risk factors such as increased age, history of coexistent disease, and increased body mass index (BMI) increase the risk of complications after such procedures [3,7]. Recently, the Charlson comorbidity index score, which factors multiple comorbidities as well as age into the score, has been used to predict complications such as surgical site infections after joint arthroplasty surgery [8]. Belmont et al investigated 46,322 patients managed with TKA and THA finding that advanced age, medically treated hypertension, and a history of cardiac disease were the most significant risk factors for postoperative cardiac complications [9]. Complications often require prolonged hospital stays and additional hospital resources that ultimately result in increased costs per hospital stay [10–12]. However, if patients are preoperatively risk stratified, many complications may be avoided [7]. Bozic et al showed that process standardization is strongly associated with improved quality and efficiency of care, and suggested that process standardization could help providers optimize quality and efficiency in total joint arthroplasty [2]. Several centers nationwide have adopted a *surgical home* technique that utilizes a standardized anesthesia-directed preoperative clinic for surgical procedures [13]. By using a hospital-standardized preoperative risk stratification process, the cost per hospital stay for hip and knee arthroplasties may decrease.

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Our hospital instituted a standardized preoperative risk stratification and optimization process for all hip and knee joint arthroplasties in 2010. Prior to 2010, joint arthroplasty patients were instructed to visit their primary care physician (PCP) for a medical clearance prior to surgery. Often the PCP was not affiliated with the hospital where the surgery was taking place, and was difficult to reach if needed postoperatively for consultation. The PCP would often recommend the patient to see a specialty service prior to clearance as well. This system led to increased time, funds, and energy for the patient as well as the physicians involved. However, after implementation of the preoperative center, patients were assessed, risk stratified, and medically optimized by our in-house preoperative center prior to surgery. Anesthesia staff physicians direct the preoperative center. However, internal medicine doctors evaluate the patients initially, risk stratify, and make recommendations for both pre-operative optimization as well as postoperative management of comorbidities. This study was carried out in a tertiary referral center with access to specialty specific physicians who are utilized for preoperative optimization. For instance, if a patient presenting to the preoperative clinic for medical clearance for a THA or TKA could be better optimized with specific attention from a specialized service such as nephrology, cardiology, pulmonology, or rheumatology, the patient will be automatically directed to a physician practicing in that field, also located in the same hospital that the surgery will take place. The internal medicine physician and the specialist service can then follow the patient postoperatively if needed. This system was standardized for all hip and knee arthritis patients.

The purpose of this study was to assess the impact of our multidisciplinary preoperative risk stratification program on the overall outcome and cost related to joint arthroplasty at a single institution. We hypothesized that by using a standardized preoperative risk stratification center for all hip and knee arthroplasties, we would see better clinical outcomes and decreased costs.

Materials and Methods

All primary and revision hip and knee joint arthroplasties performed at our institution between January 2008 and August 2012 were analyzed. Institutional review board approval was obtained for the study. Exclusion criteria consisted of acute trauma (non-elective) patients as well as patients who had incomplete medical records. We included 2598 patients. They were separated into 2 groups: triage (T) and non-triage (NT). The T group served as our experimental group and consisted of 1498 patients who were assessed at the multidisciplinary preoperative center. The NT group served as our control group and consisted of 1100 patients who underwent joint arthroplasty prior to the establishment of the preoperative center (Table 1). Three staff orthopedic surgeons specializing in joint arthroplasty performed all of the surgeries. There was no significant alteration to the approach, technique, or systems used by the three surgeons throughout the study period. Fig. 1 lists the arthroplasty procedures performed: TKA, THA, bilateral TKA (BTKA) bilateral THA (BTHA), revision TKA (Rev TKA) and revision THA (Rev THA). Postoperatively, the patients were admitted to the orthopedic service and managed primarily by the orthopedic team. A hospital medicine service was only consulted if needed for assistance with acute medical issues or if recommended by the preoperative clearance center for assistance with poorly controlled chronic medical issues. Likewise, specialty specific services were consulted as needed based on the patient's current condition and the recommendations from the preoperative center.

The T and NT groups were compared at baseline via Chi Square test for the American Society for Anesthesia Classification (ASA), and Wilcoxon test for the age unadjusted Charlson co-morbidity index score (UCCI), the age adjusted Charlson co-morbidity index score (ACCI), the sex and the length of stay (LOS). A value of $P < 0.05$ was chosen for significance, and a 95% confidence interval for the difference (CI diff) between the T and the NT cohorts was calculated from the difference. Multivariate analysis was used to evaluate possible contributing factors with regard to complication rates at 30 and 90 days postsurgery, as well as length of stay (LOS) between the T and NT groups. With the response being the sum of a fixed predefined list of complications, the complication rates were investigated using a proportional odds model with regard to cohort group, ASA, procedure type, age, sex, UCCI and ACCI. This was run once with the response variable set as the sum of complications at 30 days postsurgery and once with the response variable set as the sum of complications at 90 days postsurgery. The complications were reported via ICD-9 codes including cardiac, renal, pulmonary, deep vein thrombosis, implant failure, and infection.

The LOS was investigated using a linear regression F test once again with regard to cohort group, ASA, procedure type, age, sex, UCCI and ACCI. For each procedure type, we used the UCCI to separated the patients into minimal (UCCI score 0), moderate (UCCI scores 1–2), and high risk (UCCI score ≥ 3) groups calculated based on the score's respective 10 year mortality risk of 12%, 26%, and 56%.

Investigation through the institution's billing department was first used to confirm that no significant difference existed internally in the T or NT cohorts with regard to quarterly billing throughout the study period. The two groups were retrospectively compared quarterly throughout the study period. Hospital costs and reimbursements were adjusted to 2013 dollars using the seasonally adjusted consumer price index for medical care services published by the Bureau of Labor Statistics. A multivariate regression analysis was used to evaluate possible contributing factors with regard to total cost of operation, average cost of operation per case, total reimbursement, average reimbursement per case, total profit, and average profit per case between the T and NT cohorts. The factors investigated included cohort group, procedure type, and time. For all analysis, the procedure types and the cohort groups were treated as categorical values, while time was treated as a continuous variable which was the number of months from the earliest surgery date. We adjusted for outliers by excluding any reimbursement >$60,000 which included 10 patients. Financial data was unavailable for 24 cases in the NT cohort, and for 25 cases in the T cohort. These cases were excluded only from the financial analysis. The Bonferroni correction method was utilized to control the familywise error rate for all analyses.

Table 1
Demographics.

	Demographics			
	Non-Triage Cohort 1100 Patients		Triage Cohort 1498 Patients	
Sex	Male 464	Female 636	Male 553	Female 945
Mean Age	63.95 (±12.08)		65.39 (±11.46)	
Mean ASA	2.46 (±0.56)		2.59 (±0.57)	
Mean UCCI	1.17 (±1.41)		1.24 (±1.57)	
Mean ACCI	4 (±2.03)		4.2 (±2.04)	

(±) = standard deviation.