PATIENT FACTORS SYSTEMATICALLY INFLUENCE HOSPITAL LENGTH OF STAY IN COMMON ORTHOPAEDIC PROCEDURES

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ABSTRACT

Introduction: As the United States healthcare system evolves towards improved value delivery, patient outcomes and healthcare costs are increasingly used to evaluate physicians and provider organizations. One such metric is hospital length of stay, which has the potential to be influenced by a variety of patient characteristics and comorbidities. Determining factors influencing length of stay represents an opportunity to increase value in healthcare delivery.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database (2006-2012) was utilized to identify a cohort of 92,266 patients having one of 14 common orthopaedic procedures. A generalized linear model was utilized to identify patient factors that increase hospital length of stay.

Results: During the six-year study period, length of stay decreased significantly in the total joint arthroplasty population. Nine variables were independently associated with increased length of stay. Congestive heart failure and underweight status increased length of stay the most, at 1.46 and 1.01 days, respectively. Other factors increasing length of stay include: non-white race (0.69 days), chronic obstructive pulmonary disease (0.50 days), diabetes mellitus (0.25 days), morbid obesity (0.23 days), hypertension (0.10 days), and patient age (0.02 days for each additional year).

Discussion: In conclusion, congestive heart failure and underweight status are the greatest predictors of increased length of stay. COPD, diabetes, morbid obesity, and hypertension represent other modifiable risk factors that increase length of stay. This data can be used to counsel patients and their families regarding anticipated duration of hospitalization. Systematic targeting of patient factors known to increase length of stay represents an opportunity for cost reduction and improved value delivery. When utilizing hospital length of stay as a metric for evaluation, it is important to incorporate the factors that increase length of stay, so that orthopaedic surgeons and provider organizations can be evaluated based on representative patient population characteristics.

INTRODUCTION

The United States healthcare system is currently undergoing a process of evolution, from a system of fee for service and consumption based care to a value-based system in which patient outcomes and associated patient care costs are of paramount importance. With the development of a redefined healthcare system, metrics have been developed to increasingly evaluate surgeons' and hospitals' ability to provide cost-effective care while at the same time deliver care that leads to excellent patient outcomes. One of the most important metrics today is hospital length of stay, and this measure is increasingly used to evaluate both orthopaedic surgeons and hospitals.

The effect of patient comorbidities on length of stay in orthopaedics has been sparsely studied, with the largest studies focusing on total knee arthroplasty[1-3] and hip fractures.[4] The impact of comorbidities on hospital length of stay is still unknown for the majority of orthopaedic procedures. The largest of these studies found that the number of comorbidities significantly increased the cost of care in patients having total knee arthroplasty, with an increased cost of $400 in patients with 3 comorbidities and an increased cost of $4,000 in patient with 7 comorbidities, as well as increased length of stay in patients with multiple medical comorbidities.[1] Other studies have also showed increased cost of care in patients with an increasing number of comorbidities.[5,6] Furthermore, we know that the average length of stay in many orthopaedic procedures has decreased over time.[7,8] None of these studies, however, have identified what are the individual comorbidities and patient characteristics which can be used to target reductions in length of stay across all subspecialties of orthopaedic surgery.

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Table I. Demographic Data

Category	Description	Number of Patients
Sex	Male	37610
	Female	54464
Race	White	72295
	Non-white	19971
Anesthesia	General	55642
	Other	36624
Diabetes	Yes	13736
	No	78530
Smoking	Yes	10736
	No	81530
Alcohol use	Yes	1386
	No	90880
DNR Code Status	Yes	196
	No	92070
COPD	Yes	3545
	No	88721
CHF	Yes	313
	No	91953
BMI Class	Underweight (BMI < 18.5)	876
	Normal Weight (BMI 18.5-24.9)	15610
	Overweight (BMI 25.0-29.9)	29020
	Obese Class I (BMI 30.0-34.9	23493
	Obese Class II (BMI 35.0-39.9)	13403
	Obese Class III (BMI >40)	9864
Procedure	Total Knee Arthroplasty	46428
	Total Hip Arthroplasty	29534
	Total Shoulder Arthroplasty	2545
	Total Ankle Arthroplasty	106
	Below Knee Amputation	316
	IM Nail of Femoral Shaft Fracture	428
	IM Nail of Tibial Shaft Fracture	468
	ORIF of Femoral Neck Fracture	3062
	ORIF of Distal Radius Fracture	786
	ORIF of Scaphoid Fracture	132
	ORIF of Bimalleolar Ankle Fracture	1411
	Primary ACL Reconstruction	2488
	Primary Rotator Cuff Repair	1898
	Laminotomy and Decompression of Lumbar Spine	2664

This study was completed by analyzing the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP®) database, a large multicenter database with sufficient power to analyze complex hypotheses in a multivariate fashion. The ACS NSQIP® database is the leading nationally validated, risk-adjusted, outcomes-based program to measure and improve the quality of surgical care in hospitals. A model for outcomes-based quality improvement, ACS NSQIP collects clinical, risk-adjusted, 30-day outcomes data in a nationally benchmarked database. In addition to collecting information on patient's demographics and comorbidities, length of stay is available for each of the patients that are included in the NSQIP database.

We present a large, multi-center, multivariate analysis of the impact of patient comorbidities on hospital length of stay for a variety of common orthopaedic procedures representative of the major orthopaedic sub-specialties. The purpose of our study was to precisely determine the impact of comorbidities on hospital length of stay across the field of orthopaedic surgery, thus providing normative data to appropriately adjust expected hospital length of stay after an orthopaedic operation. We further sought to identify trends in length of stay over the 6 year study period. Finally, we suggest a targeted approach for addressing patient comorbidities and demographic risk factors which we identify to increase length of stay. We hypothesize that length of stay has decreased over time and that we would identify multiple modifiable risk factors which could be orthopaedic surgeons and their patient care teams to reduce length of stay in the future by targeting newly identified risk factors.

PATIENTS AND METHODS

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database of patients having surgery between 2006 and 2012 was utilized in this study to identify a cohort of 130,182 patients with common medical comorbidities, having one of fourteen common orthopaedic procedures. Patients with rare medical comorbidities likely to confound our analysis were excluded from the study, resulting in a final cohort of 92,266 patients. Demographic data for the cohort can be found in Table 1.

Fourteen common procedures in orthopaedic surgery, representative of each of the major orthopaedic subspecialties, were included in the analysis. We began by examining trends in length of stay over the six year study period for total hip arthroplasty and total knee arthroplasty, utilizing a linear regression model. We then utilized a generalized linear model to identify patient comorbidities which significantly influenced hospital length of stay in a multivariate manner. Comorbidities

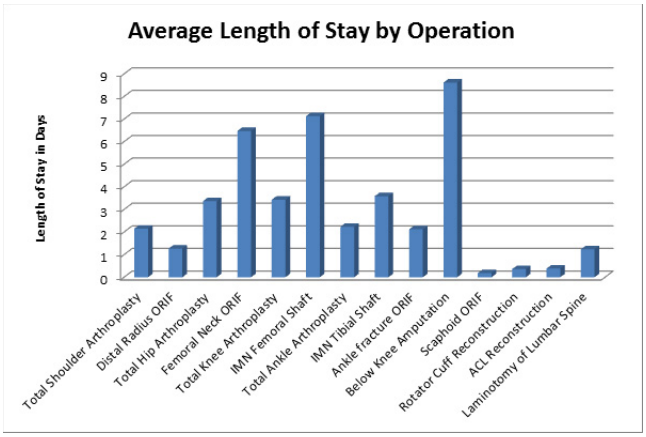

Figure 1: The average length of stay for the 14 procedures included in this study is demonstrated. Patients having a below knee amputation had the longest length of stay, followed by patients having open reduction or intramedullary nailing of various fractures common in trauma patients. Patients having a total joint arthroplasty had an average length of stay between 2-3 days. Patients having a hand, sports, or spine procedures included in the cohort had an average length of stay between 0-1 days.

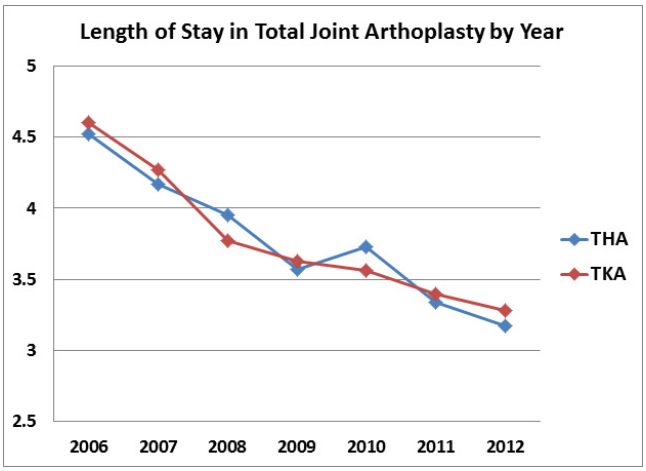

Figure 2: The average length of stay for total hip arthroplasty or total knee arthroplasty based on the procedural year is demonstrated. There was a significant decrease in length of stay for both total hip arthroplasty ($p < 0.001$) and total knee arthroplasty ($p < 0.001$) over time.

included in the analysis included: age, sex, race, anesthesia technique, body mass index (BMI), diabetes, smoking, alcohol use (EtOH) greater than 2 drinks per day, do nor resuscitate (DNR) status, history of chronic obstructive pulmonary disease (COPD), history of congestive heart failure (CHF), and hypertension (HTN). The list of comorbidities significantly increasing length of stay was compiled, with a p-value ≤ 0.05 used to define significance. The effect of BMI was studied by dividing patient into the categories of underweight (<18.5), healthy weight (18.5-24.9), overweight (25.0-29.9), obese class 1 (30-34.9), obese class 2 (35-39.9), and obese class 3 (morbid obesity) (≥40.0).

RESULTS

Length of stay for the 14 orthopaedic procedures varied substantially by the operation performed. The longest length of stay was seen in patients having a below knee amputation, at 8.6 days. The average length of stay for trauma patients were as follows: 7.1 days in patients having intramedullary nailing of a femur fracture, 6.4 days in patients having open reduction internal fixation of a femoral neck fracture, 3.6 days in patients having an intramedullary nail of a tibia fracture, and 2.1 days in patients having open reduction internal fixation (ORIF) of an ankle fracture. In total joint arthroplasty, the average length of stay for total hip arthroplasty was 3.4 days, total knee arthroplasty was 3.4 days, total shoulder arthroplasty was 2.2 days, and total ankle arthroplasty was 2.2 days. Other elective procedures in sports, hand, and spine each had average lengths of stay of approximately 1 day or less. (Figure 1)

We then considered how length of stay might have changed during the study period by considered the average length of stay in patients having total hip arthroplasty or total knee arthroplasty based on the year the procedure was performed. Utilizing a multivariate linear regression model we found a significant decrease in length of stay from 2006 to 2012 for patients having both total knee arthroplasty ($p < 0.001$) and total hip arthroplasty ($p < 0.001$). The average length of stay for patients having total hip arthroplasty in 2006 was 4.52 days, while the average length of stay in 2012 was 3.17 days. Similar results were seen in patients having total knee arthroplasty, with a length of stay of 4.60 days in 2006 compared to an average length of stay of 3.28 days in 2012. (Figure 2)

Finally, we turned our attention to identifying which factors significantly influence length of stay across all orthopaedic procedures. A total of nine separate patient comorbidities and demographic factors were found to independently increase hospital length of stay. The greatest increase in hospital length of stay was seen in patients with congestive heart failure, with an increased length of stay of 1.46 days. The second largest increase in length of stay was seen in patient classified as underweight (BMI < 18.5), with an increase in length of stay of 1.01 days. Other factors increasing length of stay included non-white race at 0.69 days, chronic obstructive pulmonary disease at 0.50 days, diabetes mellitus at 0.25 days, morbid obesity at 0.23 days, general anesthesia at 0.19 days, and hypertension at 0.10 days. Increased patient age was also found to significantly increase length of stay, with a 0.02 day increase in stay for every 1 year

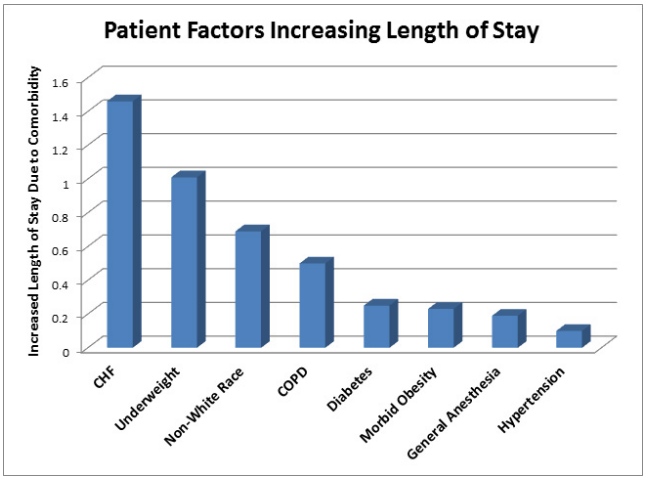

Figure 3: Multivariate analysis of patient factors which independently increase hospital length of stay. Pre-operative optimization of the listed comorbidities represents an opportunity for decreasing length of stay. Age (not included in graph) was also found to significantly increase length of stay by 0.02 days with each increasing year.

increase in age. Factors which did not significantly influence length of stay included: sex, smoking status, alcohol use, DNR code status, overweight, obesity class 1, and obesity class 2. (Figure 3)

DISCUSSION

The cost of medical care in the Unites States continues to increase at an alarming rate, with an overall cost estimate of $2.9 trillion in 2013, representing 17.3 % of our GDP, which is significantly greater than any other country in the world.[9] The average cost of a 1 day increase in patient length of stay varies by hospital, with a recent cost estimate of $2000 per day for orthopaedic surgery patients at a major level I trauma center.[10] With increasing numbers of orthopaedic operations in the United States each year, and more than 620,000 primary total knee arthroplasty procedures in 2009,[11] the cost savings from decreasing length of stay by even small amounts are tremendous. The results of this study demonstrate that patients with significant medical comorbidities can expect to have prolonged hospitalization, and therefore, increased consumption of medical resources. Factors increasing length of stay can be broken down into patient comorbidities that can optimized or modified pre-operatively, patient comorbidities which can be addressed systematically through protocols in the peri-operative setting, and patient demographics that can be targeted with pre-operative planning and patient education.

The results of this study make it clear that pre-operative optimization of cardiac, endocrine, and pulmonary function has the potential to result in significant decreases in patient length of stay. Patients with poor nutritional status also represent a significant area for pre-operative optimization, as patients that were underweight had an increased length of stay greater than 1 day. By focusing on optimizing specific high yield comorbidities including congestive heart failure, nutritional status, COPD, and diabetes prior to surgery, there is potential for improved patient care and outcomes as well as decreased medical costs through reduction in hospital length of stay. Pre-operative optimization of medical conditions by partnering with colleagues in medicine represents a significant opportunity to systematically decrease length of stay, and continuing this partnership into the peri-operative setting with protocols for treatment of identified comorbidities represents an additional opportunity for improvement.

Another area of focus for decreasing hospital length of stay can be seen in the differential length of stay found between Caucasian and non-Caucasian patients. The reasons for the difference in length of stay between Caucasians and the rest of the population are unclear. It has been demonstrated previously, however, that there is decreased access to patient care in the non-white population, and orthopeadic surgeons do not mirror the diversity seen in their patient population.[12,13] Some of the differences observed in length of stay may be attributable to cultural expectations following surgery, representing an area where improved communication pre-operatively may significantly improve length of stay. Another potential reason for the differences in length of stay may be related to socioeconomic status, as this variable was not available for patients in the NSQIP database, and patient race may be a partial surrogate for this measure. Nevertheless, pre-operative education of all patients regarding the expected post-operative course and rehabilitation expectations prior to surgery has the potential to further decrease length of stay, especially among groups that might be less familiar with the modern US healthcare system.

We found a marked decrease in length of stay in the total hip arthroplasty and the total knee arthroplasty population over a relatively short study period of six years. The average length of stay for each of these operations was reduced by more than 1.3 days over the study period. This represents a significant cost savings, and suggests that many orthopedics centers are already beginning to find ways to improve their length of stay metric. This study provides definable risk factors for increased length of stay, which allows both orthopaedic surgeons and hospital systems to target reduction in length of stay by addressing these now known risk factors. Further studies on length of stay should focus on making specific interventions to address the known risk factors, and to identify the cost-effectiveness of each of these interventions.

There were a number of limitations to this study. First, the study is a retrospective study involving hospitals which have agreed to voluntarily collect patient comorbidity and length of stay data, and thus has potential inherent bias in its retrospective nature and may not be completely representative of non-participating hospitals. Second, the study includes a sampling of multiple orthopaedic procedures representative of the subspecialties looking at the effect of comorbidities and demographic data on hospital length of stay. Some of the procedures included in the analysis are generally outpatient in nature, and thus the effects of patient factors on length of stay may be less pronounced in the outpatient surgery population. Finally, patient socioeconomic information is not available in the NSQIP database, and this is likely a significant factor in length of stay, which might be more pronounced in the non-Caucasian population.

This study demonstrates that congestive heart failure, poor nutrition, non-white race, COPD, morbid obesity, general anesthesia use, increased age, diabetes, and hypertension each lead to significantly increased length of stay in orthopaedic surgery. Orthopaedic surgeons who wish to improve patient care, decrease medical costs, and improve individual provider metrics should focus on pre-operative optimization of these risk factors, peri-operative protocol development for management in the peri-operative period, and targeted patient education throughout all phases of care when seeking to decrease length of stay in the orthopaedic patient population.

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