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Thirty-Day Readmission Rates for Total Joint Arthroplasty in
Florida Hospitals:
Are Most Due to Surgical Complications or Comorbid Conditions?

BY

Shirley Simpson Harkey

A doctoral project submitted to the faculty of the Medical University of
South Carolina in partial fulfillment of the requirements for the degree
Doctor of Health Administration
in the College of Health Professions


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THIRTY-DAY READMISSION RATES FOR TOTAL JOINT ARTHROPLASTY
IN FLORIDA HOSPITALS:
ARE MOST DUE TO SURGICAL COMPLICATIONS
OR COMORBID CONDITIONS?


by


Shirley Simpson Harkey

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Abstract of Doctoral Project Report Presented to the Executive Doctoral Program in
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Degree of Doctor of Health Administration

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Hospital readmission reduction is the focus of many policy makers and healthcare providers to reduce the health care costs and improve quality. CMS initiated the Hospital Readmissions Reduction Program (HRRP) in October 2012. Financial penalties have been exercised for excessive readmission rates after heart failure, acute myocardial infarction, and pneumonia hospitalizations. The HRRP was expanded in federal fiscal year 2015 to include total joint arthroplasty. Total joint arthroplasty is the first procedure targeted for the readmission reduction program. The reasons for readmission after an elective surgical procedure may be different than the reasons for readmission after a medical condition such as heart failure.

Using archival data from the 2012 Florida State Inpatient Database, the reasons for readmission within 30 days of discharge after a total joint arthroplasty were evaluated. Discharge data revealed 50,769 primary total joint arthroplasties with a readmission rate of 5.1%. The Medicare readmission rate was 5.8%. The most significant predictors of readmission were presence of chronic conditions and receipt of Medicaid benefits. Post-operative complications during the index admission did not significantly contribute to readmissions.

Keywords: Readmission, total joint arthroplasty, total hip arthroplasty, total knee arthroplasty, post-operative complications, comorbid conditions

CHAPTER I INTRODUCTION

Background and Need for Study

In the third year of the Hospital Readmissions Reduction Program, the Centers for Medicare and Medicaid (CMS) added payment penalties for patients readmitted within thirty days of discharge after a total joint arthroplasty (Rau, 2014). Initially, CMS exercised readmission penalties for three conditions: acute myocardial infarction, heart failure, and pneumonia (CMS, 2014). During the federal fiscal year 2015, CMS increased the maximum payment penalty to 3% of total Medicare reimbursement and added two more conditions: chronic lung problems (COPD) and elective total joint arthroplasty (Letourneau, 2014).

Total joint arthroplasty (TJA) was initially designed for patients older than 70 years of age. Today, many younger patients are meeting the criteria for this procedure, therefore increasing the nationwide demand for total joint arthroplasty. The total joint arthroplasty procedure can refer to either the total knee (TKA) or the total hip arthroplasty (THA) procedure (Kurtz, Ong, Lau, & Bozic, 2014). The total knee arthroplasty procedure is performed to improve quality of life, reduce pain, and reduce physical limitations (Cram et al., 2012). The volume of TJA procedures performed during 2001 to 2007 increased substantially. TKA increased approximately 100% in the United States and 128% in Canada during the years 1999 to 2008 (Ravi et al., 2012).

CMS initiated the Hospital Readmissions Reduction Program (HRRP) in October 2012 (Letourneau, 2014). The HRRP was established by Section 3025 of the Patient Protection and Affordable Care Act. Thus, CMS is required to reduce payments to participating hospitals with excess readmissions by tying hospital payments to readmission rates (CMS, 2014). Financial penalties are exercised against hospitals with readmission rates that exceed the national benchmark, with the goal of encouraging hospitals to reduce avoidable readmissions (Berenson & Shih, 2012). Reducing hospital readmissions may promote the national movement to improve population health, patient's experience of care, and reduction of health care costs (Berwick, Nolan, & Whittington, 2008).

Many policy makers view readmission reduction as an opportunity to reduce healthcare spending and improve quality of care. Measuring hospital readmission rates within 30 days of discharge is a relatively simple metric. Some researchers have questioned the validity of using readmission rates as a quality of care measure (Oddone & Weinberger, 2012). Factors influencing hospital readmissions are complex and controlling for confounding variables is often difficult. Hence, readmission rates may not be the best indicator of quality healthcare (Benbassat & Taragin, 2000).

However, CMS continues to implement many payment structures, involving financial rewards and penalties, to promote health care reform (Letourneau, 2014). More than half of Medicare healthcare spending nationwide is attributed to approximately 10% of Medicare beneficiaries. Policy makers and providers must understand the root of this spending before developing plans to reduce healthcare costs. Data driven decision making and policy making are essential (Joynt, Gawande, Orav, & Jha, 2013).

Financial penalties, in particular, have encouraged hospitals to focus on factors that can affect the likelihood of a thirty-day readmission. Hospitals have implemented many strategies to reduce readmission of patients with index hospitalizations for heart failure, pneumonia, or heart attack. Successful strategies to reduce readmission for these chronic conditions have focused on coordination of care, access to care, and patient education (Letourneau, 2014). However, patient centered strategies to reduce readmissions after total joint arthroplasty are evolving because surgical readmissions are driven by different elements than medical readmissions (Weber & Greenberg, 2014).

Berenson and Shih (2012) examined the 30-day readmission rate for pneumonia, heart failure, and acute myocardial infarction for safety-net hospitals. A safety-net hospital provides care to large numbers of low-income and socioeconomically vulnerable patients. Their findings revealed that readmission rates for safety-net hospitals were more likely to be higher than non-safety-net hospitals. Safety net hospitals are just as likely to admit patients for elective surgeries, such as TJA, as they are to admit patients for non-elective reasons, such as pneumonia, heart failure, and acute myocardial infarction (Berenson & Shih, 2012).

The addition of the readmission penalty for TJA was unexpected for some hospital administrators. For example, an eastern North Carolina community hospital determined their TJA readmission penalty of \$99,000 resulted from one excessive readmission in a three year period, July 2010 through June 2013. After an internal review, this eastern North Carolina “safety-net” hospital determined that the majority of these readmissions were not related to customary post-operative orthopaedic complications, rather were related to existing comorbidities (R. Craig, personal

communication, September 9, 2014). Penalties of this magnitude for joint replacement may be problematic for patients and hospitals alike.

Gu et al. (2014) concluded that the Medicare HRRP has the potential to reduce access to care for minorities and low income patients, consequently increasing existing health care disparities. However, the HRRP also could reduce those same disparities, depending on the national policy development (Gu et al., 2014). The TJA readmission penalty for hospitals could have unintended consequences for patients in need of this procedure. Presence of readmission risk factors prior to elective TJA could inversely incentivize a physician decision to perform these procedures on high risk patients. Physicians could require patients to delay surgery until specific BMI (body mass index) measures are achieved. Physicians may avoid surgery on the obese patient (W. DeAraujo, M.D., personal communication October 27, 2014).

Orthopaedic surgeons from the New York Hospital for Joint Diseases have explored the ethics related to delaying surgery in patients with multiple risk factors for post-operative complications. Physicians must balance the decision to provide quality-of-life improving surgery versus delaying the TJA surgery until certain patient-dependent risk factors are modified. Medical optimization of varying risk factors, such as diabetes, can reduce complication risks. In contrast, some patient risk factors, such as a disability, cannot be easily modified. Patients can have an active role in reduction of reduce patient-dependent, modifiable risk factors, such as obesity and tobacco use (Bronson et al., 2014).

Problem Statement

For patients with moderate to severe osteoarthritis, the total joint arthroplasty (TJA) procedure has been considered safe and effective for more than two decades (Lalmohamed et al., 2014). It is one of the most common surgical procedures in the United States and the demand for TJA continues to grow (Kurtz, Ong, Lau, & Bozic, 2014; Lehil & Bozic, 2014). If total knee and total hip arthroplasty procedures continue at the current rate, the estimated U.S. demand for these procedures will increase 174% and 673%, respectively, by the year 2030 (Kurtz, Ong, Lau, & Bozic, 2014). Population growth, the aging society, and public expectations for quality of life all contribute to the increase in demand for arthroplasty (Lehil & Bozic, 2014).

Mortality after TJA has reduced as result of new surgical techniques, the improvement of perioperative and post-operative care, and improvement in the surgical care of older patients with multiple comorbidities (Lalmohamed et al., 2014). Although post-operative mortality has declined, complications have increased. The major complications are pulmonary embolism, sepsis, non-myocardial infarction cardiac complications, and pneumonia (Kirksey et al., 2012). A patient's risk for post-operative complications increases with the presence of chronic conditions, such as diabetes, cardiac disease, and obesity. Advanced age can increase the risk for post-operative complications resulting in readmission (Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014). The morbidly obese patient, with a body mass index $\geq 40 \text{ kg/m}^2$, has an increased risk of readmission for revision surgery after a total knee arthroplasty (Watts et al., 2014). There appears to be a correlation between aging, increased number of comorbidities, and risk of complications (Schairer, Vail, & Bozic, 2014).

Hospital administrators and orthopaedic surgeons could develop programs to assist patients in managing the patient-dependent risk factors such as obesity, tobacco use, or glycemic control for patients with diabetes. Readmission rates after TJA could be reduced if patients were required to take personal responsibility for wellness and for managing personal risk factors like tobacco use, weight control, and glycemic control. Perhaps tailoring pre-operative preparation programs to the needs of the TJA patients could serve as a strategy to reduce TJA readmissions (Callahan, Adair, Bozic, Manning, J. Saleh & K. Saleh, 2014). However, a retrospective analysis of administrative, claims data for patients with TJA should be conducted prior to development and implementation of such strategies.

Preventable readmissions present an opportunity to improve care coordination and reduce health care expenses (Bhalla & Kalkut, 2010). Research regarding factors that drive readmission is necessary to determine best practices for improving care coordination. Post-operative complications can be an obvious reason for an unplanned readmission after TJA. Presence of comorbid conditions also may contribute to an unplanned 30-day hospital readmission. Patients requiring TJA may be more likely to have chronic comorbid conditions that require hospital admission within 30 days after discharge from the TJA hospitalization. This study was designed to clarify the relationship between medical comorbidities and readmission rates after TJA.

Objective of the Study

The study objective was to analyze administrative data for conditions associated with readmission after TJA. Specifically, the analysis should yield the 30 day TJA

readmission rate, identify contributing factors associated with this readmission rate, and review the readmission patterns after total joint arthroplasty.

The findings could help to guide the development of readmission avoidance programs. Programs could be developed to focus on improving pre-operative preparation of the patient, reducing hospital acquired conditions, and / or improving the discharge plan.

Research Questions

Emphasis on readmission avoidance is largely driven by legislative and financial agendas. However, clinical outcomes are also important to the multidisciplinary care team and hospital administrators (Walsh & Hripcsak, 2014). The following questions have been addressed and can serve to assist administrators and providers in development of TJA readmission avoidance programs.

Research question number 1. What is the TJA readmission rate? What are the primary reasons for the TJA readmission?

Research question number 2. If TJA readmissions are largely related to chronic medical conditions, will the presence of comorbid conditions increase the likelihood of an unplanned readmission within 30 days of discharge?

Research question number 3. If TJA readmissions are largely related to comorbid conditions, how many co-existing conditions will trigger the readmission?

Research question number 4. If TJA readmissions are largely related to post-operative complications, was there a complication during the index hospital stay?

Hypotheses

The majority of TJA readmissions are more likely to be related to comorbid conditions instead of post-operative arthroplasty complications. The total joint arthroplasty 30-day, all-cause readmission rate is higher in patients with at least two comorbid conditions, as compared to the readmission rate for patients with less than two comorbid conditions, excluding rheumatoid arthritis as a comorbid condition. The following research hypotheses can be studied.

Hypothesis H₁. Less than 50% of readmissions are due to complications from joint replacement. The number of TJA 30-day readmissions related to medical comorbidities is significantly higher than 30-day readmissions related to post-operative complications.

Hypothesis H₂. Patients with 2 or more comorbid conditions are more likely to be readmitted within 30 days, as compared to patients with 0 or 1 comorbid conditions.

Rationale for hypotheses. The trigger point for measuring ≥ 2 comorbid conditions was determined from the literature. The majority of the U.S. population has a minimum of one comorbid condition. Approximately 60% of patients in the pioneering Elixhauser study have one or more comorbidities (Elixhauser, Steiner, Harris, & Coffey, 1998). Other researchers have estimated that 60% to 88% of the Medicare age population has one or more comorbidities (Bjorgul, Novicoff, & Saleh, 2010). The age of the patient and the prevalence of comorbidities are positively related, as are the prevalence of comorbidities and patient outcomes (Elixhauser, Steiner, Harris, & Coffey, 1998).

Population

The total joint arthroplasty (also known as a total joint replacement) is a surgical procedure performed to replace the human hip or knee joint with a metal, plastic, or ceramic prosthesis. Ankle, wrist, shoulder, and elbow joints may also be replaced with a prosthetic implant (American Academy of Orthopaedic Surgeons, 2014). This study population is limited to the hip and knee arthroplasty procedures. The population includes patients, of all ages and payor sources, who have an elective primary total hip or total knee arthroplasty procedure. Unplanned readmissions are counted in this study if the readmission occurred within 30 days of discharge from the index admission. Thirty-day readmissions following the index TJA are limited to one readmission event (YNHHSC/CORE, 2014).

CHAPTER II REVIEW OF THE LITERATURE

A literature review was conducted to expand on the background and need for this study, analyze previous research, and review other study designs. The primary objective of the literature review was to explore readmission risk factors, readmission reasons, and readmission rates following index hospitalization for total joint arthroplasty. The review attempted to clarify an understanding of the national initiatives to reduce hospital readmissions. Medicare Hospital Readmission Reduction Program (HRRP) and associated federal penalties for readmissions were examined. The national quality transparency initiative as related to readmission rates was explored. The possibility of a relationship between post-operative TJA outcomes and presence of pre-existing comorbid conditions was probed. Articles scrutinizing coding accuracy and utilization of administrative data for health sciences research were reviewed. The review was comprehensive and also included readmission studies on non-TJA populations.

Method

The literature review began with a search of the PubMed database. Key search words included, but were not limited to, readmission, readmission rates, total joint arthroplasty, total hip arthroplasty, total knee arthroplasty, readmission risk factors, readmissions and quality measures, readmissions and the Affordable Care Act, Hospital Readmission Reduction Program, comorbidity, post-operative complications, and administrative data. Abstracts of citations yielded from this search were reviewed and

electronic full-text articles were downloaded. While reading abstracts and articles, additional peer reviewed articles were identified, subsequently located, and electronically downloaded using PubMed. Articles not available electronically were obtained from the Medical University of South Carolina Library.

Peer-reviewed articles also were obtained by scanning the 2013 and 2014 table of contents for *The Journal of Bone and Joint Surgery* and *The Journal of Arthroplasty*. Electronic full-text articles were downloaded from these journals' websites. Another database search using the *Google* search engine yielded several relevant newspaper and periodical articles on federal fiscal year (FFY 2015) Medicare fines and penalties.

All searches were completed from September to December 2014. These search methods yielded approximately 150 articles relevant to the research questions. Other pertinent information was obtained from several websites sponsored by professional organizations such as the Centers for Medicare and Medicaid (CMS), the Healthcare Cost and Utilization Project (HCUP), and the Agency for Healthcare Research and Quality (AHRQ).

Significance of Reducing Readmission Rates

Medicare unplanned readmissions have been estimated to cost \$17.4 billion, annually. One out of every five Medicare patients, approximately 20%, was readmitted within 30 days of discharge in 2004 (Jencks, Williams, & Coleman, 2009).

The Medicare Hospital Readmission Reduction Program (HRRP) was launched in October 2012. Initially, hospitals paid a 1% penalty for excessive 30 day readmissions for heart failure, pneumonia, and acute myocardial infarction. In 2015, CMS increased the penalty to 3% and expanded the HRRP to include COPD (chronic obstructive

pulmonary disease) and elective total joint arthroplasty (Letourneau, 2014). The readmission reduction program goal is to reduce wasteful health care spending resulting from poor care coordination. Failure in transitions of care resulted in an estimated \$25 to \$45 billion in wasteful Medicare spending in 2011 (Berwick & Hackbarth, 2012).

The CMS National Strategy for Quality Improvement in Health Care established a national goal for a 20% reduction in hospital readmission rates by the end of 2013. Perhaps the aggressive goal was established because the Medical Payment Advisory Commission (MedPAC) has resolved that hospital readmissions are costly, numerous, and usually preventable (Kocher & Adashi, 2011). The Med PAC has determined that 75% of 30-day readmissions are preventable (Weber & Greenberg, 2014). While the national 20% reduction goal has not been achieved, the readmission rates appear to be moving in the correct direction. Data analysis revealed Medicare readmission rate reductions of 1% to 5% in 2012 (Gerhardt et al., 2013).

To date, certain key factors have not been considered in policy making regarding the readmission penalties for 30 day readmissions. For example, specific patient demographics could be considered when establishing hospital readmission penalties. The 2003 Institute of Medicine report on racial and ethnic disparities documented 20 years of differences in health among certain races and ethnicities. However, race, ethnicity, preferred language, education level, and patient income are not included in the current Medicare readmission calculation methodology. CMS does allow a risk adjustment for socioeconomic factors such as education level, health status, and primary language risk when calculating the HCAHPS (Hospital Consumer Assessment of Healthcare Providers) score for individual hospitals (Bhalla & Kalkut, 2010). However, the Medicare

readmission rate is not risk adjusted based on socioeconomic status (Weber & Greenberg, 2014).

The HRRP has additional factors for consideration in the calculation methodology. Some people are concerned that the readmission rate calculation could include planned readmissions in the all-cause readmission rate. Overstating the readmission rate can penalize an already financially challenged hospital. Many hospitals serve as a safety net for socioeconomically disadvantaged patients. However, many healthcare providers believe that readmissions result from patient specific factors that cannot be controlled by hospitals (Weber & Greenberg, 2014).

Planned versus Unplanned Readmissions

The Medicare HRRP is focused on reduction of unplanned hospital readmissions. CMS has defined unplanned readmission as an adverse event requiring hospitalization within 30 days of the index hospitalization. Yale New Haven Health Services Corporation / Center for Outcomes Research and Evaluation (YNHHSC/CORE) has clearly defined inclusion and exclusion criteria to determine the patient cohort and to calculate the Medicare 30 day all-cause readmission rate. Examples of planned readmissions include admissions for surgical procedures that require more than one operation or for follow up chemotherapy treatment after initial chemotherapy treatment (YNHHSC/CORE, 2014).

Simply stated, planned readmissions are usually elective and scheduled; therefore, they are not necessarily related to the index admission. Thirty-seven procedures have been identified by CMS as reasons for a planned readmission even if the procedure is performed after an index hospitalization. Likewise, CMS has identified sixty-six

conditions or diagnoses as reason for an unplanned readmission, even if one of the 37 planned procedures is performed (Sacks et al., 2014). The procedures listed in Appendix A qualify as a planned readmission. The conditions for unplanned readmission are listed in Appendix B. After comparing the list of procedures in Appendix A to the list of conditions and diagnoses in Appendix B, it is apparent that avoiding the Medicare readmission penalty is difficult.

Unplanned readmissions are also known as preventable readmissions. Clinically related to the index admission, unplanned readmissions following a surgical procedure provide treatment for a complication resulting from care during the index admission or for recurrence of a problem that was not corrected by surgical intervention. Conversely, the unplanned readmission also may be attributed to exacerbation of chronic illness regardless of the reason for the index admission (Goldfield et al., 2008).

Overall Readmission Reasons and Rates

Jencks, Williams, and Coleman (2009) conducted a landmark study regarding 30 day readmissions of Medicare beneficiaries, regardless of index diagnosis. Using the MEDPAR (Medicare Provider Analysis and Review) data year 2004, the all-cause readmission rate was determined to be 19.6% (Jencks, Williams, & Coleman, 2009). The current CMS hospital-wide readmission rate is 15.6% (CMS, 2014b).

The Jencks, Williams, and Coleman (2009) study included more than 13 million Medicare patients. The primary reasons for index hospitalization included both medical diagnoses and surgical procedures. Heart failure, pneumonia, and COPD were identified in the top 10 reasons for readmission. Patients, with an index admission for a medical condition, comprised 77.6% of all of the readmitted patients. The proportion of the

surgical patients readmitted was 22.4%. Heart failure and pneumonia were the top two reasons for readmission for all surgical patients. However, the top reasons for readmission for specific surgical procedures, like TJA, did not include heart failure and pneumonia. Reasons for readmission after surgical procedures (e.g., cardiac stent placement, hip or knee surgery, major bowel surgery, or other vascular surgery) were related to the procedure performed during the index hospitalization. Total joint arthroplasty was one of the top diagnoses associated with surgical readmissions. However, the most frequent reason for readmission after hip and knee arthroplasty was “aftercare” (Jencks, Williams, & Coleman, 2009). Apparently, the inclusion and exclusion criteria for defining readmissions, in this study, were similar to the methodology and criteria used in the CMS readmissions measure methodology.

Postoperative readmissions

Approximately one in eight post-operative Medicare patients is readmitted within 30 days of discharge (Robert Wood Johnson Foundation, 2013). Recent research suggests that different factors precipitate re-hospitalization after a surgical procedure versus a medical admission (Weber & Greenberg, 2014).

Lawson et al. (2013) provided evidence that unplanned surgical readmissions are more likely to occur in patients with a post-operative complication. Patients with post-operative complications, as defined by the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP), had a higher probability of readmission than surgical patients without complications. The post-operative complications included surgical site infections, wound disruption, pneumonia, pulmonary embolism, and renal complications. In a retrospective study using the ACS-NSQIP

database, 53% of readmitted surgical patients had a post-operative complication. Orthopaedic surgical procedures were not on the list of top 20 surgical procedures resulting in the largest number of 30 day post-operative readmissions (Lawson et al., 2013). Nonetheless, TKA patients experiencing an adverse event during the hospital stay had an increased chance of having a longer length of stay with an increase in readmission (Huddleston et al., 2009).

Lucas et al. (2013) used the ACS-NSQIP database to calculate the 30 day readmission rate for general, vascular, and thoracic surgery performed in 2011. The readmission rate in this study ranged from 5% to 16%, depending on the surgical subspecialty. Prior to discharge from the index hospitalization, 6.4% of the patients sustained a post-operative complication. At least one pre-operative medical condition, such as heart failure, COPD, diabetes, or dialysis, was recorded in 83.9% of the patients (Lucas et al., 2013). Jencks, Williams, and Coleman (2009) noted 70.5% of surgical discharges were readmitted to a medical condition. The presence of preoperative medical conditions was attributed to an increased risk of readmission following pancreatoduodenectomy (Hyder et al., 2013).

Infections, gastrointestinal related, wound related, and cancer treatment related were the main reasons for readmission after a surgical procedure, including orthopaedic surgery, at the University of Pennsylvania Hospital in 2009. Discharge disposition, age, gender, race, COPD, and diabetes were not associated with an increase in readmission. However, DVT (deep vein thrombosis) and acute renal failure conveyed an increased risk of readmission. The Pennsylvania results are limited because of the sample size (Morris et al., 2011).

Total Joint Arthroplasty Readmissions

The Florida Orthopedic Society and the Florida Hospital Association conducted a retrospective study regarding 15 day readmissions after total hip arthroplasty using data from April 2009 to March 2010. Three orthopedic surgeons from Miami served as principal investigators and reviewed readmission reasons, rates, and contributing factors. The primary purpose of their study was to evaluate whether readmission rates reflected quality of care (Lavernia, Villa, & Iacobelli, 2013). This study was conducted prior to the addition of total joint arthroplasty to the HRRP.

Lavernia, Villa, and Iacobelli (2013) calculated a rate of 5.0% for 15 day readmissions after a total hip arthroplasty. The following readmission risk factors were explored in this study: payer source, discharge disposition, and presence of a mental health condition. The majority of readmissions in this study resulted from an infectious process, not limited to surgical site infections. Medicare was the payer source for 71% of the readmissions. Patients discharged to skilled nursing facilities (SNF) also had higher readmission rates than patients with other discharge dispositions. Patients with a mental health condition were readmitted more often than patients without this past medical history. Patient demographics, socioeconomic resources, and most comorbid conditions were not measured and this may be a limitation of the study (Lavernia, Villa, & Iacobelli, 2013).

In a different retrospective study, the 15 day readmission rate for total hip arthroplasty (THA) in Florida was 7.5% (Goldfield et al., 2008). Goldfield et al. (2008) analyzed all readmissions, not just THA, using Florida hospital data from 2004 and 2005. Severity of illness, patient age, and mental illness were variables associated with

predicting a potential readmission. The study recognized that many readmissions are not preventable and described a method to calculate the potentially preventable readmissions using administrative data (Goldfield et al., 2008).

Reasons for all readmissions in this study were attributed to either medical care or surgical procedure. In either case, the reason for readmission could be related to deterioration of a chronic illness, a complication from care during the index admission, or recurrence of the condition that caused the index admission. The medical readmission rate related to acute exacerbation of chronic medical conditions, such as congestive heart failure, was 24.8%. Readmissions for a medical complication potentially related to the surgery occurred at a rate of 36.3%. Improper management of a post-operative urinary catheter was cited as a reason for a medical readmission related to a surgical procedure. Regardless of the treatment, medical care versus surgical care, the readmission rate to address a complication was 40.5%. The THA readmission rate resulting from decompensation of a comorbid condition was much lower than the readmission rate attributed to a surgical complication (Goldfield et al., 2008).

Readmission rates and reasons from other TJA readmission studies. The 15 day THA readmission rate (5.0%) calculated by Lavernia, Villa, and Iacobelli (2013) was lower than the 15 day THA readmission rate (7.5%) determined in the Goldfield et al. (2008) study. As documented in other studies, the unplanned 30 day readmission rate, after total hip arthroplasty and/or total knee arthroplasty, ranged from 3.6% to 6.8% (Clement et al., 2013; Kiridly et al., 2014; Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014; Mesko et al., 2014; Pugely, Callaghan, Martin, Cram, & Gao, 2013; Schairer, Sing, Vail, & Bozic, 2014; Schairer, Vail, & Bozic, 2014; Vorhies, Wang,

Herndon, Maloney, & Huddleston, 2011; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2012).

Reasons for readmission included infection, procedure related complications, CHF, and cardiac related conditions (Clement et al., 2013; Kiridly et al., 2014; Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014; Pugely, Callaghan, Martin, Cram, & Gao, 2013; Schairer, Sing, Vail, & Bozic, 2014; Schairer, Vail, & Bozic, 2014; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2011; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2012). Wound infections, wound dehiscence, sepsis, DVT, and pulmonary embolism were among the primary procedure related complications (Pugely, Callaghan, Martin, Cram, & Gao, 2013). Additional surgical complications included joint dislocation and post-operative hematoma (Schairer, Vail, & Bozic, 2014).

Septic joint, cardiovascular events, thrombotic events, and diagnoses unrelated to the procedure were common reasons for readmission after TJA. Diagnoses unrelated to the TJA procedure resulted in approximately 30% of the 30 day readmissions in a Canadian study. Prostate conditions and cellulitis were cited as examples of readmission diagnoses unrelated to the TJA (Avram, Petrucci, Winemaker, & deBeer, 2014).

Findings from research by William Schairer and his colleagues support the belief that surgical diagnoses are responsible for the majority of 30 day readmissions after TJA. Schairer, Sing, Vail, and Bozic (2014) determined medical and surgical causes for readmission after total hip arthroplasty. Schairer, Vail, and Bozic (2014) conducted a similar study using total knee arthroplasty patients. Medical conditions, such as *Clostridium difficile* infection or renal failure, triggered 40% of the 30 day readmissions after TKA; therefore, 60% of the readmissions were attributed to surgical causes

(Schairer, Vail, & Bozic, 2014). Likewise, 73% of readmissions after THA resulted from surgical reasons. Dislocation, surgical site infection, hematoma, DVT, and non-infected draining wound characterized reasons for surgical readmissions after THA (Schairer, Sing, Vail, & Bozic, 2014).

Medical reasons, mostly cardiac and pulmonary related, provided rationale for almost half of the post TJA readmissions in the Saucedo et al. (2014) study. Vorhies, Wang, Herndon, Maloney, and Huddleston (2011) found that CHF, ischemic heart disease, and cardiac dysrhythmias are the top three reasons for readmissions after THA. Medical diagnoses accounted for 45% of the readmissions after TKA in the analysis by Adelani, Keeney, Nunley, Clohisy, and Barrack (2013).

Much emphasis has been placed on reducing healthcare spending and healthcare waste through reduction of hospital 30 day readmissions. Jencks, Williams, and Coleman (2009) documented evidence that “aftercare” was the most frequent cause for readmission after hip and knee arthroplasty. Subsequent TJA specific studies did not confirm their conclusion. Inadequate social support or physical medicine support in the home environment could emerge as a risk factor for readmission. However, study findings have not supported this hypothesis (Avram, Petrucci, Winemaker, & deBeer, 2014).

Risk factors for TJA Readmission

Readmission after surgery has been associated with post-operative complications as well as patient age and comorbidities (Hyder et al., 2013). Risk factors for unplanned readmissions may include hospital care processes and outcomes as well as patient specific variables. Patient specific variables include, but are not limited to,

socioeconomic status, age, ethnicity, gender, and medical history. However, prevalence of medical comorbidities can be a predictor of hospital readmission (Joynt, Orav, & Jha, 2011).

Medical history. Medical reasons, such as cardiac and pulmonary disease, account for approximately 43% of TJA readmissions. Past medical history of coronary artery disease, pneumonia, acute myocardial infarction, and CHF significantly increase the risk of TJA readmission (Saucedo et al., 2014). Patients with comorbid diagnoses of diabetes, COPD, bleeding disorders, hypertension, and obesity have a higher readmission rate after TJA than patients without these diseases (Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014).

Obesity. Obesity is defined as having a body mass index (BMI) ≥ 30 kg/m² (Inacio et al., 2014). Several studies have linked obesity to increased risk of readmission after joint replacement. Prevalence of obesity continues to rise in the United States. Data from 2010 suggest that approximately one-third of adults are obese (Kremers, Visscher, Kremers, Naessens, & Lewallen, 2014; Inacio et al., 2014).

Obesity prevalence in total joint patients is comparable to the national data. Watts et al. (2014) reported obesity prevalence of 33.3% in his TKA study. Lübbecke, Stern, Garavaglia, Zurcher, and Hoffmeyer (2007) reported an obesity prevalence rate of 23.6% in the THA population. Singh and Lewallen (2014) suggest that obesity rates are increasing over time.

TJA patients with BMI (body mass index) ≥ 40 kg/m² have a higher readmission rate than patients with a normal BMI (18.5kg/m² to < 25 kg/m²) (Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014). Obesity is a well-documented risk factor for

post-operative morbidity (Inacio et al., 2014). Obesity is associated with an increased length of hospital stay, both with and without prevailing obesity related comorbid conditions (Kremers, Visscher, Kremers, Naessens, & Lewallen, 2014). Patients with a longer length of hospitalization are more likely to be readmitted within 30 days of the index orthopaedic surgical admission (Dailey, Cizik, Kasten, Chapman, & Lee, 2013).

Post-operative complications in obese patients. After primary THA in Switzerland, the incidence of infection was substantially higher in women with BMI ≥ 30 kg/m² (Lübbecke, Stern, Garavaglia, Zurcher, & Hoffmeyer, 2007). Overall readmission rates are higher for the obese TJA patient and can cause surgical site infections (Inacio et al., 2014). However, Inacio et al. (2014) cautioned orthopaedic providers to interpret these study findings with care.

Other TJA post-operative complications have been tied to obesity. The incidence rate for hip dislocation is 2.3 times higher in obese patients than in non-obese patients. Prosthesis failure also has been linked to obese patients (Lübbecke, Stern, Garavaglia, Zurcher, & Hoffmeyer, 2007).

Comorbid conditions. Treatment decisions, post-operative complications, and survival rates are impacted by existence of chronic medical conditions, also known as comorbid conditions. Prevalence of comorbidities in Medicare patients undergoing TJA have nearly doubled since 1991 (Cram et al., 2012; Cram et al., 2011). Comorbid disease impacts the outcome of total joint arthroplasty (Bjorgul, Novicoff, & Saleh, 2010).

In some studies, the presence of pre-operative comorbidities is significantly associated with TJA readmissions. Congestive heart failure and COPD are risk factors for developing post-operative complications during the index hospitalization (Huddleston et

al., 2009). The risk for THA post-operative complications is tied to history of cardiac disease and diabetes (Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014). Saucedo et al. (2014) reported a higher likelihood of readmission after TKA for patients with coronary artery disease.

Anemia, pre-operative narcotic usage, and pre-operative anticoagulation are also associated with readmissions after THA and TKA (Mesko et al., 2014). Pre-operative anticoagulation used to treat atrial fibrillation increases the odds of post-operative complications such as periprosthetic joint infection (Aggarwal et al., 2013).

Depression has been known to negatively influence quality of life, including pain management. One author reported depression in 10% of the TJA population in his research. Depression is associated with many post TJA complications including pulmonary embolism, infection, and anemia (Browne, Sandberg, D'Apuzzo, & Novicoff, 2014).

Comorbid diseases and conditions do not consistently correlate with risk of readmission after THA or TKA. Avram, Petruccelli, Winemaker, and deBeer (2014) did not correlate cardiovascular history with readmission for a cardiovascular diagnosis. Morris et al. (2011) determined that pre-existing conditions did not predict the need for unplanned readmission.

However, medical comorbidities can be important predictors of complications and subsequent hospital readmissions (Schairer, Vail, & Bozic, 2014). Identification of a single comorbidity to predict risk for post TJA readmission has not materialized (Mesko et al., 2014). The risk of readmission increases as the number of comorbidities per patient increases (Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014; Gu et al.,

2014). Various investigations have recorded approximately two comorbidities per patient (Cram et al., 2011; Cram et al., 2012; Singh & Lewallen, 2014).

Multiple studies have supported the association of comorbid conditions with the risk of readmission after TJA. Conversely, research conducted at Tufts Medical Center did not substantiate an association between comorbidities and increased readmission risk after TJA. Comorbidities in the Tufts study included hypertension, diabetes, coronary artery disease, COPD, asthma, and depression. Patients with increased BMI had an inclination for increased readmission, but the finding was not statistically significant (Tayne, Merrill, Smith, & Mackey, 2014).

Patient Specific Variables. Other factors have been considered to be influential regarding risk of readmission. Age, race, gender, socioeconomic status, marital status, and insurance coverage have been considered in addition to baseline health. Socioeconomic factors, income, and discharge disposition can drive the readmission rate (Lavernia, Villa, & Iacobelli, 2013). Age is associated with significantly higher rates of readmission (Clement et al., 2013). Patients of increased age have higher odds of developing post-operative complications resulting in readmission (D'Apuzzo, Pao, Novicoff, & Browne, 2014; Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014). Greater risk of post-operative events is associated with advanced age (Huddleston et al., 2009). Age is not associated with readmission after TJA in all research (Mesko et al., 2014; Tayne, Merrill, Smith, & Mackey, 2014).

Racial disparities have been evaluated for readmission risk. African American patients are more likely to be readmitted after CHF, AMI, and pneumonia index admissions (Joynt, Orav, & Jha, 2011). A higher rate of post op complications was noted

in African American patients following TKA, but no difference was noted following THA (Ibrahim et al., 2005). The odds of readmission were significantly increased after orthopaedic surgery at the University of Washington Medical Center for patients of African-American, American Indian, and Alaskan Native races (Dailey, Cizik, Kasten, Chapman, & Lee, 2013). Black race can be an independent predictor of readmission after total knee replacement (Zmistowski et al., 2013). Black race is also an independent predictor for risk of readmission after hip replacement, colectomy, coronary artery bypass graft, and abdominal aortic aneurysm surgeries (Tsai, Orav, & Joynt, 2014). However, race is not always found to influence the odds of readmission after THA (Clement et al., 2013; Mesko et al., 2014; Tayne, Merrill, Smith, & Mackey, 2014).

Male sex is positively correlated with risk of readmission after TJA (Brown, Banerjee, Russell, Mont, & Huo, 2014; Pugely, Callaghan, Martin, Cram, & Gao, 2013; Zmistowski et al., 2013). Male sex increases the risk for surgical site infection after total knee arthroplasty (Mortazavi, Schwartzberger, Austin, Purtill, & Parvizi, 2010). Conversely, Tayne, Merrill, Smith, and Mackey (2014) associated female gender with primary TJA readmissions.

Hospitals with the highest proportion of African-American patients and with the highest Medicaid rate have more post-operative TJA complications (Bozic et al., 2014). Patients with Medicaid insurance had higher odds of readmission than other payor sources (Dailey, Cizik, Kasten, Chapman, & Lee, 2013). Medicare and Medicaid insurance have been determined as independent risk factors for readmission following TJA (Mesko et al., 2014).

Length of stay and discharge disposition. The trend toward reducing hospital length of stay to reduce healthcare costs has increased in acceptance (Ramos et al., 2014b). Overall the reduction in length of stay did not affect the readmission rate (Vorhies, Wang, Herndon, Maloney, & Huddleston, 2011; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2012). Length of stay has been connected with discharge disposition. Some patients require a longer length of stay prior to discharge to a skilled nursing facility. Some patients are able to transition care earlier if discharged to a skilled nursing facility following TJA (Sharareh, Le, Hoang, & Schwarzkopf, 2014). Patients' need for additional care due to comorbid conditions could drive the decision for discharge disposition (Ramos et al., 2014a) Patients discharged to home have a lower chance of readmission than patients discharged to a skilled nursing facility (Bini et al., 2010; Ramos et al., 2014a). Readmission rate varies by discharge disposition (Riggs, Roberts, Aronow, & Younan, 2010).

Conclusions

By 2019, the Affordable Care Act is expected to reduce CMS spending by approximately \$670 billion through reimbursement cuts and penalties. Reducing readmissions can have a huge impact on health care spending (Berwick & Hackbarth, 2012). The challenge is to develop public policy that does not have unintended consequences that limit access to care (Gu et al., 2014). Creating a generalized financial penalty for all readmissions suggests that every patient's baseline health status, demographic indicators, and risk of complications are equal (Mesko et al., 2014).

The literature review revealed mixed results regarding factors affecting readmission rates following primary, elective total joint arthroplasty. Conventional logic

would lend the researcher to accept an association between comorbid conditions and post-operative complications. Weber and Greenberg (2014) support developing opportunities to optimize the patient's medical condition prior to TJA surgery.

CHAPTER III METHODOLOGY

Study Design and Hypotheses

A retrospective cross sectional analysis of TJA admissions was conducted to analyze administrative data for risk factors predictive of readmission after TJA. The primary aim of the study was to evaluate the prevalence of comorbid conditions and post-operative complications requiring readmission to the hospital within 30 days of the index total joint arthroplasty procedure. Other factors influential to readmission risk such as patient race, ethnicity, age, sex, and payor source were also measured. Relationships between comorbid conditions, post-operative complications, and demographic characteristics were evaluated. The secondary aim of the study was to compute the number of comorbid conditions present in index and readmitted patients.

This study's research hypotheses were designed to explore outcomes after total joint arthroplasty and provide pertinent information to drive readmission reduction programs for total hip and total knee replacement procedures. Specifically, the research hypotheses were designed to determine whether readmissions within 30 days of a primary total joint arthroplasty procedure are more likely to be related to pre-existing comorbid conditions instead of post-operative complications.

Hypothesis H₁. Less than 50% of readmissions are due to complications from joint replacement. TJA 30-day readmissions related to medical comorbidities are significantly higher than 30-day readmissions related to post-operative complications.

Hypothesis H₂. Patients with 2 or more comorbid conditions are more likely to be readmitted within 30 days, than patients with 0 or 1 comorbid conditions.

Population and Sample

All inpatient discharges from Florida hospitals with an index admission for a total joint arthroplasty (TJA) procedure were used for this analysis. Existing archival data was obtained from the 2012 Florida State Inpatient Database (SID).

De-identified data was used. The study was classified as non-human research by the Medical University of South Carolina (MUSC) Institutional Review Board (IRB).

This study population reflects the CMS definition for the total hip arthroplasty and total knee arthroplasty readmission measure; however, data from all payors were used. To be included in the study population, the episode of care must reflect an elective, primary total joint arthroplasty during an index admission (AHRQ, 2014). TJA admissions with ICD-9-CM procedure code 81.54 and 81.51 were used to identify total knee arthroplasty and total hip arthroplasty, respectively (Hart, Stegman, & Ford, 2012).

Exclusion criteria were applied to refine the study population. Admissions with more than one arthroplasty procedure were excluded. Discharges with disposition documented as short-term hospital, cancer center, against medical advice (AMA), acute inpatient rehabilitation hospital, or expired were excluded from the study population. Emergent admissions were also excluded. In addition to the index admission, re-admissions within thirty days of discharge from the TJA were grouped. Data included all payor and Medicare. Figure 1 depicts the study population with identification of inclusion and exclusion criteria.

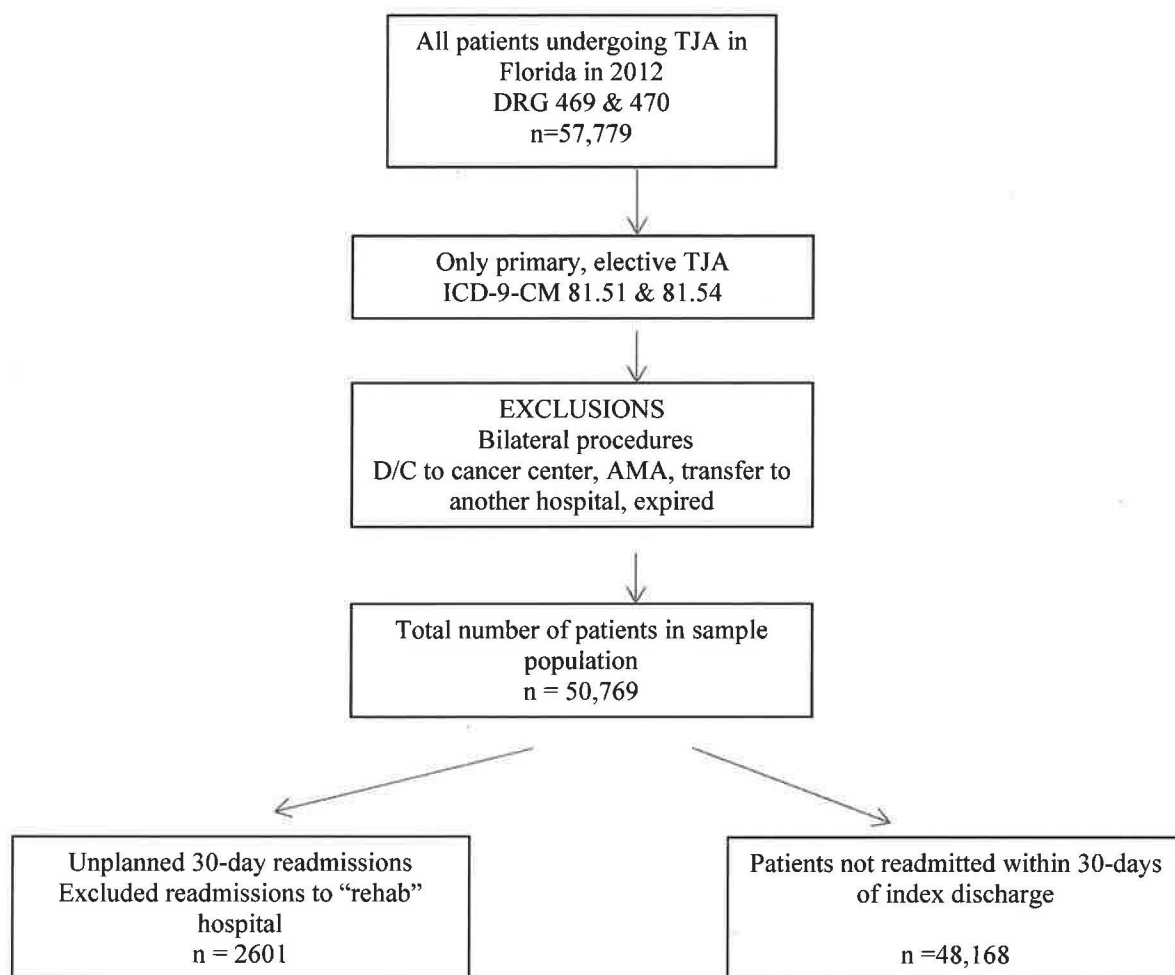


Figure 1. Inclusion and exclusion criteria for study population.

Definition of Variables

Thirty-day readmission after discharge from a total joint arthroplasty was the outcome variable. The thirty-day readmission event following the index admission was limited to one readmission event. The hospital readmission period begins with the date of discharge from the index hospitalization and ends on the 31st day after discharge (AHRQ, 2014).

The predictor variables were post-operative complications and comorbid conditions. Patient specific, independent variables such as age, race, gender, and payor source were also predictor variables.

Post-operative complications after TJA included acute myocardial infarction, acute venous thrombosis and embolism (VTE), post-operative anemia, cardiac complications, deep vein thrombosis (DVT), hematoma, post-operative infection, post-operative pneumonia, pulmonary embolism, and urinary tract infection. Diagnosis codes for the complications are listed in Table 1.

Table 1

Post-operative Complications

Diagnosis	ICD-9-CM code
Acute Myocardial Infarction (AMI)	410.0
Acute venous thrombosis (VTE)	453.40
	453.41
	453.42
Anemia (post-operative)	285.9
Cardiac complication	997.1
Deep vein thrombosis (DVT)	451.1
	451.11
	451.19
Hematoma	998.12
Infection, post-operative	998.59
Pneumonia (post-operative)	997.39
Pulmonary embolism	415.11
Urinary tract infection (post-operative)	599.0
	997.5

Comorbid conditions, also known as chronic conditions, included the 31 comorbid conditions captured in the Florida SID and identified using the CCS (clinical classifications software) single level diagnosis clusters (Healthcare Cost and Utilization Project, 2015). The comorbid conditions analyzed in this study and included obesity, mental illness, substance abuse, depression, dementia congestive heart failure (CHF),

chronic obstructive pulmonary disease (COPD), and diabetes. The ICD-9-CM codes as defined in the H-CUP Comorbidity software were used to analyze the chronic diagnoses.

Data Set Description

Archival data from the 2012 Florida SID includes abstracted clinical and demographic information from all inpatient Florida hospital discharges. The data is made available through an agreement facilitated by the Agency for Healthcare Research and Quality (AHRQ) for the Healthcare Cost and Utilization Project (H-CUP). The data is made available for this research study through an agreement between H-CUP and Dr. Kit Simpson, Professor at the Medical University of South Carolina. The student completed the required H-CUP data use agreement training and authenticated the H-CUP data use agreement.

The 2012 Florida SID includes 135 data elements. The data elements analyzed in this study included age, gender, marital status, race, admission type, admission diagnosis, principal diagnosis, 31 AHRQ comorbidity measures, diagnosis present on admission (POA indicator), length of stay, number of chronic conditions, operating room procedure, and primary expected payer. A “visit” variable was available to link multiple hospital visits across time and maintain patient privacy. The term “verified person number” is used to describe this visit link, but does not reveal any recognizable patient specific information (Healthcare Cost and Utilization Project, 2015).

Data Analysis

Univariate analysis was conducted to describe the distribution of age, sex, ethnicity, payor, procedure type, presence of chronic conditions, and presence of post-operative complications for the TJA population. The thirty-day readmission rate was

calculated. Another univariate analysis was conducted for the thirty-day readmissions. The readmission analysis described the distribution of age, sex, ethnicity, payor, procedure type, chronic conditions, and post-operative complications.

Frequency distribution was used to determine the number of chronic conditions per patient for the index admission and readmission. The numbers of chronic conditions per patient were clustered into categories of low, moderate, and high. Low was defined as < 4 chronic conditions. Moderate was defined as 4 to 6 chronic conditions. High was defined as > 6 chronic conditions. Descriptive statistics were determined. A new variable, “LowMedHi” was developed and used in the regression analytics.

Frequency of post-operative complication was determined for the index admission as well as for the readmission. The analysis was not limited to primary diagnosis for readmission. Any mention of post-operative complication was included in the readmission reasons analysis.

Multivariate frequency distribution was constructed with a 2 x 2 contingency table. The cross tabulation of the variables 30-day readmission (with and without post-operative complication) and presence of post-operative complication (during index stay and readmission) was analyzed. The significance of the difference in these proportions was assessed using Chi-square test and Fisher’s exact test.

Risk factors for readmission were identified using multivariate logistic regression models. Odds ratio (OR) was calculated for each variable of interest. Predictor variables of interest were payor source, sex, ethnicity, volume of comorbid conditions per patient, specific comorbid conditions, and presence of post-operative complication during index

admission. Statistical significance was defined as $P < 0.05$ and the confidence interval was set at 95%. The data were analyzed using SAS software version 9.3 (SAS Institute, Inc., Cary, North Carolina).

Limitations

The key limitation of this study is the use of administrative claims data. Much had been written about the validity and reliability of administrative data for readmission research. Administrative data in the United States uses the ICD-9-CM coding methodology. Coded data are primarily used for billing and reimbursement purposes. The accuracy of clinical coded data to reflect diagnoses, complications, and comorbidities has been challenged (Mears et al., 2002). However, the use of administrative data for this study is very relevant. Administrative coded data are used by CMS to determine payment methodologies and penalties.

The ability to differentiate comorbid conditions from complications is but one limitation of administrative data (Cram, Bozic, Callaghan, Lu, & Li, 2014). Nonetheless, Cram, Ibrahim, Lu, and Wolf (2012) determined that administrative data can be used to evaluate complications. Accuracy of administrative data is dependent on the accuracy of the physician documentation as well as the skill of the medical records coder (Bozic et al., 2010).

Physician training and skill to perform the TJA and the number of annual procedures performed by the physician could influence patient outcomes. Administrative data does not include this level of physician information. Adoption of evidence based clinical cath paths and specific patient education have also been suggested Joint registries

include clinical abstracted data and may provide the health science researcher with the ability to control for additional confounding variables (Ayers & Franklin, 2014).

Strength of the study comes from the ability to generalize the results. A large statewide database was used and included data from all payors. Florida demographics for age > 65 years, sex, black race, and Hispanic ethnicity are very similar the United States demographics (U.S. Census Bureau, 2013)

THIRTY-DAY READMISSION RATES FOR TOTAL JOINT ARTHROPLASTY
IN FLORIDA HOSPITALS:
ARE MOST DUE TO COMPLICATIONS OR COMORBID CONDITIONS?

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Abstract

Hospital readmission reduction is the focus of many policy makers and healthcare providers to reduce the health care costs and improve quality. CMS initiated the Hospital Readmissions Reduction Program (HRRP) in October 2012. Financial penalties have been exercised for excessive readmission rates after heart failure, acute myocardial infarction, and pneumonia hospitalizations. The HRRP was expanded in federal fiscal year 2015 to include total joint arthroplasty. Total joint arthroplasty is the first procedure targeted for the readmission reduction program. The reasons for readmission after an elective surgical procedure may be different than the reasons for readmission after a medical condition such as heart failure.

Using archival data from the 2012 Florida State Inpatient Database, the reasons for readmission within 30 days of discharge after a total joint arthroplasty were evaluated. Discharge data revealed 50,769 primary total joint arthroplasties with a readmission rate of 5.1%. The Medicare readmission rate was 5.8%. The most significant predictors of readmission were presence of chronic conditions and receipt of Medicaid benefits. Post-

operative complications during the index admission did not significantly contribute to readmissions.

Keywords: Readmission, total joint arthroplasty, total hip arthroplasty, total knee arthroplasty, post-operative complications, comorbid conditions

Introduction and Background

The Medicare Hospital Readmissions Reduction Program (HRRP) was expanded to include elective total joint arthroplasty for the federal fiscal year 2015. Payment penalty was increased to 3% of a hospital's total Medicare reimbursement for patients readmitted within thirty days of discharge after a total joint arthroplasty. The HRRP was established to reduce unplanned readmissions within 30 days of the index hospitalization. Initially, the program was limited to three medical conditions: acute myocardial infarction, heart failure, and pneumonia (Letourneau, 2014).

Many policy makers view readmission reduction as an opportunity to reduce healthcare spending and improve quality of care by applying financial penalties to hospitals for excessive readmission rates (Berenson & Shih, 2012; Oddone & Weinberger, 2012). Reducing unplanned hospital readmissions promotes the national goal to improve population health, the patient's experience of care, and reduce health care costs (Berwick, Nolan, & Whittington, 2008). Determining hospital 30-day readmission rates is a relatively simple metric. Identification of risk factors influencing readmission is complex (Benbassat & Taragin, 2000).

Hospital administrators and physicians have implemented many strategies to reduce readmission rates, improve quality, and minimize financial penalties. Readmission rate reduction for chronic conditions such as acute myocardial infarction, heart failure, and pneumonia resulted from an emphasis on coordination of care, access to care, and patient education (Letourneau, 2014). However, standardized programs to

reduce total joint arthroplasty readmissions have not fully emerged because surgical readmissions are driven by different risk factors than medical readmissions (Weber & Greenberg, 2014).

Jencks, Williams, and Coleman (2009) conducted a retrospective study regarding 30 day readmissions including more than 13 million Medicare beneficiaries hospitalized for both medical diagnoses and surgical procedures, including total joint arthroplasty. Readmissions for heart failure, pneumonia, and COPD comprised 77.6% of all of the readmitted patients. The proportion of the surgical readmissions was 22.4%. Heart failure and pneumonia were the top two reasons for readmission for all surgical patients readmitted. Total joint arthroplasty was one of the top index procedures associated with surgical readmissions (Jencks, Williams, & Coleman, 2009).

Post-operative mortality after total joint arthroplasty has declined and post-operative complications have increased. The major TJA post-operative complications are pulmonary embolism, sepsis, non-myocardial infarction cardiac complications, and pneumonia (Kirksey et al., 2012). Lawson et al. (2013) provided evidence that surgical patients with post-operative complications have a higher probability of readmission than surgical patients without complications. Huddleston et al. (2009) concluded that TKA patients experiencing an adverse event during the hospital stay had an increased chance of having a longer length of stay with an increase in readmission.

Medical comorbidities can be important predictors of complications and subsequent hospital readmissions (Joynt, Orav, & Jha, 2011; Schairer, Vail, & Bozic, 2014). Conversely, research conducted at Tufts Medical Center did not substantiate an association between comorbidities and increased readmission risk after TJA (Tayne,

Merrill, Smith, & Mackey, 2014). It is important to note that prevalence of comorbidities in Medicare patients undergoing TJA has nearly doubled since 1991 (Cram et al., 2012; Cram et al., 2011).

The presence of advanced age and chronic conditions, such as diabetes, cardiac disease, obesity, depression, congestive heart failure and chronic obstructive pulmonary disease has been shown to increase the patient's risk for post-operative complications after TJA (Browne, Sandberg, D'Apuzzo, & Novicoff, 2014; Huddleston et al., 2009; Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014). Saucedo et al. (2014) reported a higher likelihood of readmission after TKA for patients with coronary artery disease. The morbidly obese patient, with a body mass index ≥ 40 kg/m², has an increased risk of readmission for revision surgery after a total knee arthroplasty (Watts et al., 2014). Obesity is a well-documented risk factor for post-operative morbidity (Inacio et al., 2014).

Anemia, pre-operative narcotic usage, and pre-operative anticoagulation are also associated with readmissions after THA and TKA (Mesko et al., 2014). Pre-operative anticoagulation used to treat atrial fibrillation increases the odds of post-operative complications such as periprosthetic joint infection (Aggarwal et al., 2013). There appears to be an association between aging, number of comorbidities, and risk of complications (Schairer, Vail, & Bozic, 2014).

Identification of a single comorbidity to predict risk for post TJA readmission has not materialized (Mesko et al., 2014). The risk of readmission increases as the number of comorbidities per patient increases (Gu et al., 2014; Mednick, Alvi, Krishnan, Lovecchio,

& Manning, 2014). Various investigations have recorded approximately two comorbidities per patient (Cram et al., 2011; Cram et al., 2012; Singh & Lewallen, 2014).

Other risk factors for unplanned readmissions may include hospital care processes and outcomes as well as patient specific variables. Patient specific variables include, but are not limited to, payer source, socioeconomic status, age, ethnicity, gender, and discharge disposition (Lavernia, Villa, & Iacobelli, 2013; Stefan et al., 2012).

Documented in several studies, the unplanned 30 day readmission rate after total hip arthroplasty and/or total hip arthroplasty ranges from 3.6% to 6.8% (Clement et al., 2013; Kiridly et al., 2014; Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014; Mesko et al., 2014; Pugely, Callaghan, Martin, Cram, & Gao, 2013; Schairer, Sing, Vail, & Bozic, 2014; Schairer, Vail, & Bozic, 2014; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2011; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2012).

Reasons for readmission include infection, procedure related complications, CHF, and cardiac related conditions (Clement et al., 2013; Kiridly et al., 2014; Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014; Pugely, Callaghan, Martin, Cram, & Gao, 2013; Schairer, Sing, Vail, & Bozic, 2014; Schairer, Vail, & Bozic, 2014; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2011; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2012). Wound infections, wound dehiscence, sepsis, DVT, and pulmonary embolism are among the procedure related complications (Pugely, Callaghan, Martin, Cram, & Gao, 2013). Additional surgical complications include joint dislocation and post-operative hematoma (Schairer, Vail, & Bozic, 2014).

Findings from research by William Schairer and his colleagues support the belief that surgical diagnoses are responsible for the majority of 30 day readmissions after TJA.

Schairer, Sing, Vail, and Bozic (2014) determined medical and surgical causes for readmission after total hip arthroplasty. Schairer, Vail, and Bozic (2014) conducted a similar study using total knee arthroplasty patients. Medical conditions, such as *Clostridium difficile* infection or renal failure, triggered 40% of the 30 day readmissions after TKA; therefore, 60% of the readmissions were attributed to surgical causes (Schairer, Vail, & Bozic, 2014). Likewise, 73% of readmissions after THA resulted from surgical reasons. Dislocation, surgical site infection, hematoma, DVT, and non-infected draining wound characterized reasons for surgical readmissions after THA (Schairer, Sing, Vail, & Bozic, 2014).

Medical reasons, mostly cardiac and pulmonary related, provided rationale for almost half of the post TJA readmissions in the Saucedo et al. (2014) study. Vorhies, Wang, Herndon, Maloney, and Huddleston (2011) found that CHF, ischemic heart disease, and cardiac dysrhythmias are the top three reasons for readmissions after THA. Medical diagnoses accounted for 45% of the readmissions after TKA in the analysis by Adelani, Keeney, Nunley, Clohisy, and Barrack (2013).

Other factors have been considered to be influential regarding risk of readmission. Age, race, gender, socioeconomic status, marital status, and insurance coverage have been considered in addition to baseline health. Socioeconomic factors, income, and discharge disposition can drive the readmission rate (Lavernia, Villa, & Iacobelli, 2013). Age is associated with significantly higher rates of readmission (Clement et al., 2013). Patients of increased age have higher odds of developing post-operative complications resulting in readmission (D'Apuzzo, Pao, Novicoff, & Browne, 2014; Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014). Greater risk of post-operative events is

associated with advanced age (Huddleston et al., 2009). Age is not associated with readmission after TJA in all research (Mesko et al., 2014; Tayne, Merrill, Smith, & Mackey, 2014).

Racial disparities have been evaluated for readmission risk. African American patients are more likely to be readmitted after CHF, AMI, and pneumonia index admissions (Joynt, Orav, & Jha, 2011). A higher rate of post op complications is noted in African American patients following TKA, but no difference was noted following THA (Ibrahim et al., 2005). The odds of readmission were significantly increased after orthopaedic surgery at the University of Washington Medical Center for patients of African-American, American Indian, and Alaskan Native races (Dailey, Cizik, Kasten, Chapman, & Lee, 2013). Black race is believed to be an independent predictor of readmission after total knee replacement (Zmistowski et al., 2013). Black race is also believed to be an independent predictor for risk of readmission after hip replacement, colectomy, coronary artery bypass graft, and abdominal aortic aneurysm surgeries (Tsai, Orav, & Joynt, 2014). However, all research does not support race as a variable to influence the odds of readmission after THA (Clement et al., 2013; Mesko et al., 2014; Tayne, Merrill, Smith, & Mackey, 2014).

Male sex has been positively correlated with risk of readmission after TJA (Brown, Banerjee, Russell, Mont, & Huo, 2014; Pugely, Callaghan, Martin, Cram, & Gao, 2013; Zmistowski et al., 2013). Male sex increases the risk for surgical site infection after total knee arthroplasty (Mortazavi, Schwartzberger, Austin, Purtill, & Parvizi, 2010). However, Tayne, Merrill, Smith, and Mackey (2014) associated female gender with primary TJA readmissions.

Hospitals with the highest proportion of African-American patients and with the highest Medicaid rate have been found to have more post-operative TJA complications (Bozic et al., 2014). Patients with Medicaid insurance had higher odds of readmission than other payor sources (Dailey, Cizik, Kasten, Chapman, & Lee, 2013). Medicare and Medicaid insurance have been determined as independent risk factors for readmission following TJA (Mesko et al., 2014).

The study objective was to analyze administrative claims data for risk factors predictive of readmission after TJA. Specifically, the 30 day TJA readmission rate and contributing factors associated with readmissions were assessed. Relationships between chronic conditions, post-operative complications, and demographic characteristics were evaluated. The findings can give guidance for appropriate resource allocation to develop plans to decrease TJA readmissions.

While scientific logic would suggest that post-operative complications are an obvious reason for an unplanned readmission after TJA, we hypothesized that the majority of unplanned readmissions result from chronic conditions. A secondary study aim was to determine whether or not patients with 2 or more comorbid conditions were more likely to be readmitted.

The research hypotheses were designed to determine whether or not readmissions within 30 days of a primary total joint arthroplasty procedure are more likely to be related to pre-existing comorbid conditions or post-operative complications.

Hypothesis H₁. Less than 50% of readmissions are due to complications from joint replacement. The TJA 30-day readmissions related to medical comorbidities are significantly higher than 30-day readmissions related to post-operative complications.

Hypothesis H₂. Patients with 2 or more comorbid conditions are more likely to be readmitted within 30 days, than patients with 0 or 1 comorbid conditions.

Materials and Methods

A retrospective cross sectional analysis of total joint arthroplasty (TJA) admissions was conducted. The study guidelines followed the CMS definition for the total hip arthroplasty and total knee arthroplasty readmission measure. To be included in the study population, the episode of care reflected an elective, primary total joint arthroplasty during an index admission (AHRQ, 2014). Admissions with more than one arthroplasty procedure performed during the index hospitalization were excluded. Specific UB-04 discharge dispositions were also excluded. Discharges with disposition documented as short-term hospital, cancer center, against medical advice, or expired were excluded from the study population.

TJA data analysis included total knee arthroplasty (TKA) admissions with ICD-9-CM procedure code 81.54 and total hip arthroplasty admissions with ICD-9-CM procedure code 81.51. Unplanned readmissions within thirty-days of discharge from the index stay were detected. Unplanned readmissions to rehab hospitals were excluded. All data analysis included a comparison of the Medicare population versus the all payor population. After applying inclusion and exclusion criteria, there were 50,769 index admissions and 2,601 readmissions for analysis. Refer to Figure 1 for an outline of the inclusion and exclusion criteria.

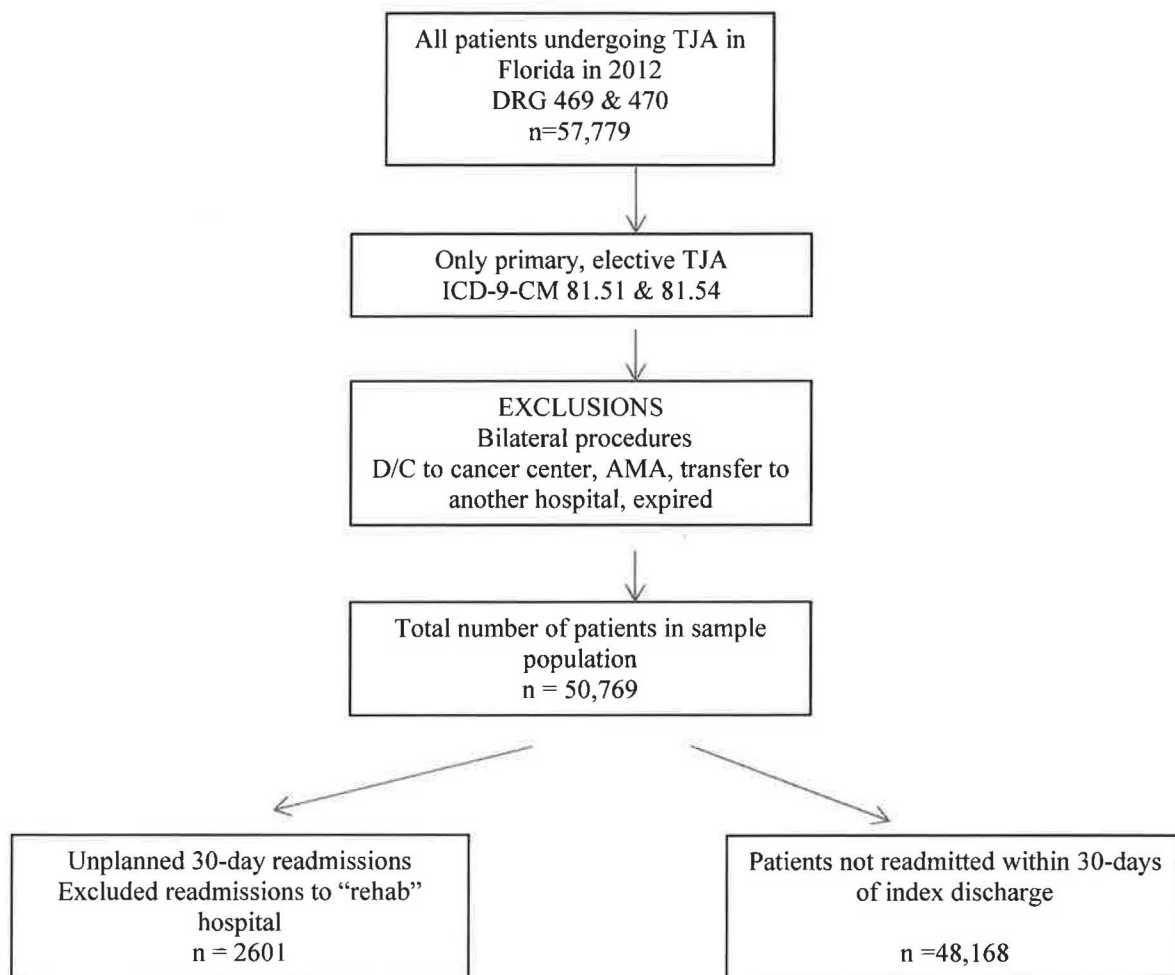


Figure 1. Inclusion and exclusion criteria for study population.

Existing archival data was obtained from the 2012 Florida State Inpatient Database (SID) for the study analysis. The Agency for Healthcare Research and Quality has facilitated an agreement between healthcare providers, state government, and federal government to capture abstracted clinical and non-clinical information at the state (SID) and national (NIS or national inpatient sample) levels. The Florida SID includes abstracted clinical and demographic information from all inpatient Florida hospital discharges, regardless of payor source. The Florida SID contained 135 data elements. A “visit” variable in the Florida SID allowed the researcher to study multiple hospital visits

during the 2012 data period (Healthcare Cost and Utilization Project, 2015). Multiple readmissions and readmissions to inpatient acute rehab hospitals were not included in the 30-day readmission sample.

De-identified data was used. The study was classified as non-human research by the Medical University of South Carolina (MUSC) Institutional Review Board (IRB).

Univariate analysis was conducted to describe the distribution of age, sex, ethnicity, payor, procedure type, presence of chronic conditions, and presence of post-operative complications for the TJA population. The thirty-day readmission rate was calculated. Another univariate analysis was conducted for the thirty-day readmissions. This analysis described the distribution of age, sex, ethnicity, payor, procedure type, chronic conditions, and post-operative complications.

The Florida SID identified 31 comorbid conditions using the CCS (clinical classifications software) single level diagnosis clusters (Healthcare Cost and Utilization Project, 2015). Comorbid conditions, also known as chronic conditions, were analyzed in this study and included obesity, mental illness, substance abuse, depression, dementia congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and diabetes.

Frequency distribution was used to determine the number of chronic conditions per patient for the index admission and readmission. The numbers of chronic of conditions per patient were clustered into categories of low, moderate, and high. Low was defined as < 4 chronic conditions. Moderate was defined as 4 to 6 chronic conditions. High was defined as > 6 chronic conditions. Descriptive statistics were

determined. A new variable, “LowMedHi” was developed and used in the regression analytics.

Post-operative complications after TJA included acute myocardial infarction, acute venous thrombosis and embolism (VTE), post-operative anemia, cardiac complications, deep vein thrombosis (DVT), hematoma, post-operative infection, post-operative pneumonia, pulmonary embolism, and urinary tract infection. Frequency of post-operative complication was determined for the index admission as well as for the readmission. The analysis was not limited to primary diagnosis for readmission. Any mention of post-operative complication was included in the readmission reasons analysis. Diagnosis codes for the complications are listed in Table 1.

Table 1

Post-operative Complications

Diagnosis	ICD-9-CM code
Acute Myocardial Infarction (AMI)	410.0
Acute venous thrombosis (VTE)	453.40
	453.41
	453.42
Anemia (post-operative)	285.9
Cardiac complication	997.1
Deep vein thrombosis (DVT)	451.1
	451.11
	451.19
Hematoma	998.12
Infection, post-operative	998.59
Pneumonia (post-operative)	997.39
Pulmonary embolism	415.11
Urinary tract infection (post-operative)	599.0
	997.5

Multivariate frequency distribution was constructed with a 2 x 2 contingency table. The cross tabulation of the variables 30-day readmission (with and without post-operative complication) and presence of post-operative complication (during index stay

and readmission) was analyzed. The significance of the difference in these proportions was assessed using Chi-square test and Fisher's exact test.

Risk factors for readmission were identified using multivariate logistic regression models. Odds ratio (OR) was calculated for each variable of interest. Predictor variables of interest were payor source, sex, ethnicity, volume of comorbid conditions per patient, specific comorbid conditions (as defined earlier), and presence of post-operative complication during index admission. Several regression models were applied excluding obesity and depression. Obesity was not statistically significant at a P value of 0.8608. Statistical significance was defined as $P < 0.05$ and the confidence interval was set at 95%. The data were analyzed using SAS software version 9.3 (SAS Institute, Inc., Cary, North Carolina).

Results

A total of 50,769 patients were identified with primary, elective total knee arthroplasty or total hip arthroplasty. There were 2,601 unplanned readmissions within 30 days of discharge. The total knee procedure was performed more often than the total hip arthroplasty. The composition of the patient population was 67.9% Medicare, 2.19% Medicaid, 26.34% commercial insurance, 60.32% female, 7.15% black, and 8.09% Hispanic. Two-thirds of the total joint arthroplasty patients were Medicare beneficiaries. The majority of the total joint arthroplasty patients were female. Very few of the patients were identified as black race or Hispanic ethnicity. Patient age ranged from 13 to 105 years, with a mean age of 67.87 years. Demographic characteristics are listed in Table 2. The characteristics of the Medicare patients are very similar to the non-Medicare patients.

Table 2

Patient Demographics by Payor

Demographic Characteristic	All Payor	Medicare Only
Total	50,769	34,513
Hip Arthroplasty	37.06%	35.53%
Knee Arthroplasty	62.94%	64.47%
Female	60.32%	62.42%
Black	7.15%	5.77%
Hispanic	8.09%	8.36%
Mean Age (years)	67.87	72.64

The majority of the TJA patients had comorbid conditions present. Less than 1.0% (39) of the patients did not have a comorbid condition identified during the index admission. The number of comorbidities per patient ranged from 1 to 20 with a mean of 8.9 conditions per patient for all payors and 9.06 conditions per Medicare patient. The median number of comorbid conditions per patient was 4. Up to 7 comorbid conditions was present in 86.02% of the index population. The frequency distribution for percent of patients with more than one comorbid condition during the index stay is reflected in Figure 2.

For the readmitted patients, comorbid conditions ranged from 1 to 18 conditions per patient. The distribution was similar to the index population. However, all of the readmitted patients had at least one comorbid condition. The median was around 5. Almost 70% of the readmissions had ≥ 6 comorbid conditions.

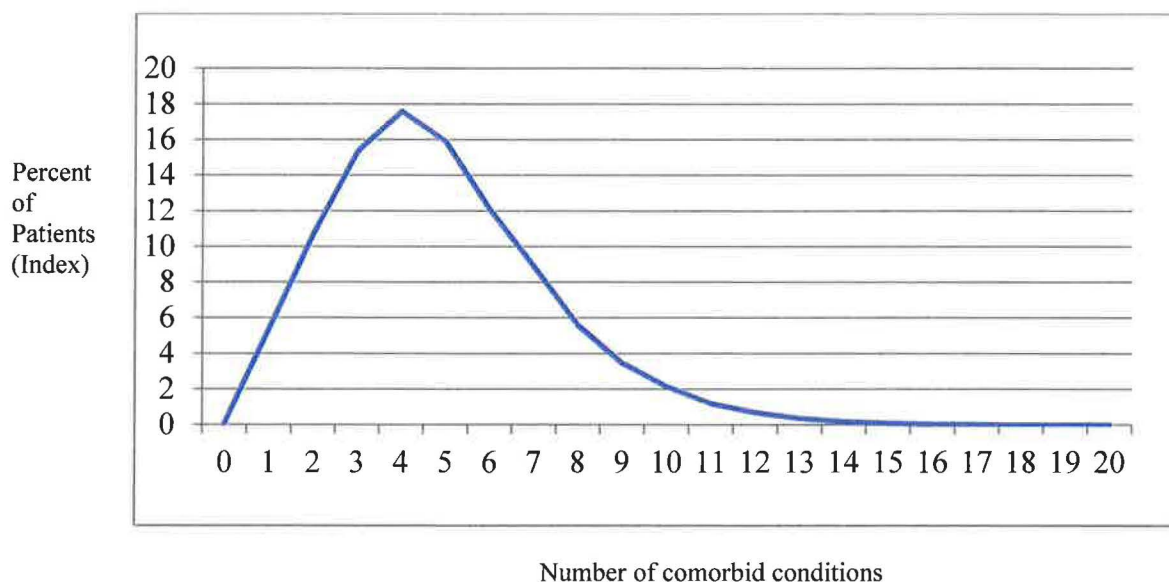


Figure 2. Frequency Distribution for Percent of Patients by Number of Comorbid Conditions found during index admission.

The overall unplanned 30-day TJA readmission rate for all payors was 5.1% (n=2601 of 50,769). Medicare TJA patients were readmitted at a rate of 5.9% (n=2029 of 34,513). A comparison of the demographic characteristics of the index admissions and the readmissions is reflected in Table 3.

Table 3.

Patient Demographics: Index Admission Compared to Re-Admission, All Payors

Demographic Characteristic	Index Admission	Readmission
Total	50,769	2601
Hip Arthroplasty	37.06%	36.56%
Knee Arthroplasty	62.94%	61.44%
Female	60.32%	55.21%
Black	7.15%	8.5%
Hispanic	8.09%	10.23%
Mean Age (years)	67.87	70.0

Table 4 depicts a comparison of the readmissions by payor. Again, there was little difference between the demographic characteristics of the Medicare patients and the non-Medicare patients.

Table 4.

Patient Readmission Demographics by Payors

Demographic Characteristic	All Payor	Medicare
Readmission rate	5.1%	5.9%
Hip Arthroplasty	36.56%	38.64%
Knee Arthroplasty	61.44%	61.36%
Female	55.21%	56.73%
Black	8.5%	7.10%
Hispanic	10.23%	10.20%
Mean Age (years)	70.07	73.73

Readmissions, resulting from a post-operative complication, occurred at a rate of 28.57%. The majority of the readmissions, 71.43%, were not related to a post-operative complication. Table 5 compares the number of readmission reasons for all payors to the number of readmissions for Medicare.

Table 5.

Readmission Reasons by Payor

Readmission Reason	All Payor	Medicare
Post-operative complication present	28.57%	28.49%
No post-operative complication	71.43%	71.51%

During the index admission, the most frequently occurring comorbid conditions were depression, obesity, and COPD. The distribution of comorbid conditions in the readmitted patients mirrored the index stay patients. However, the incidence was higher in the readmitted patients. Table 6 compares the frequency of comorbid conditions for the index stay with the readmission.

Table 6.

Frequency of Comorbid Conditions in Index Admission and Readmission, All Payor

Comorbid Condition	Index Admission	Readmission
Obese	17.46%	19.11%
Depression	13.62%	17.03%
COPD	7.0%	12.34%
Diabetes	3.02%	5.31%
Mental Illness (includes substance abuse)	2.62%	5.31%
CHF	2.03%	5.19%
Dementia	1.30%	3.5%

Despite the frequency found in the TJA population, obesity ($p = 0.8608$) was not significantly associated with predicting readmission. The odds of readmission were highest in patients with dementia, congestive heart failure, and mental illness (including substance abuse). Dementia was present in 1.3% of the patients undergoing TJA. Females were 33% less likely to be readmitted. Compared to patients with 1, 2, or 3 comorbid conditions present, patients with 4 to 6 comorbidities, the odds of readmission were increased by 27%, and for patients with 7 or more comorbid conditions the odds of readmission increased by 78%, compared to patients with 1 to 3 comorbid conditions. Patients with Medicaid were 90% more likely to be readmitted than patients with other payor sources. Table 7 reflects the odds ratio for analysis of the likelihood of readmission based on chronic condition groups, payor, age, sex, and ethnicity. The values are given as the odds ratio with the 95% confidence interval in parentheses.

Table 7.

Predictors of Readmission after Total Joint Arthroplasty, All Payors

Predictors	Odds Ratio	P value
Dementia	1.939 (1.536 – 2.447)	< .0001
Medicaid	1.902 (1.511 – 2.393)	< .0001
Congestive Heart Failure	1.761 (1.452 – 2.136)	< .0001
Mental Illness / Substance Abuse	1.692 (1.404 – 2.039)	< .0001
COPD	1.413 (1.243 – 1.605)	< .0001
Diabetes	1.349 (1.121 – 1.624)	0.0016
Black	1.338 (1.154 – 1.552)	0.0001
4 to 6 Comorbid conditions present	1.267 (1.137 – 1.411)	0.2270
7 + Comorbid conditions present	1.77 (1.565 – 2.017)	<.0001
Depression	1.143 (1.020 – 1.282)	0.0218
Age	1.014 (1.009 – 1.019)	< .0001
Obese	1.010 (0.907 – 1.125)	0.8608
Female	0.772 (0.711 – 0.838)	< .0001
Commercial Insurance	0.689 (0.607 – 0.782)	< .0001

Cross tabulation of readmission and post-operative complication variables was used to study differences in readmission reasons. Table 8 depicts a comparison of readmission reasons with presence of Post-operative complications. Of the 2601 patients that were readmitted within 30 days, 743 patients (28.57%) were readmitted with post-operative complication and 1858 (71.43%) were readmitted for other reasons. Post-operative complications present during the index admission, but not during the readmission, occurred in 10.57% of readmission population. Readmissions, without a post-operative complication during either the index stay or the readmission, occurred 52.86% of the time.

Of the 743 patients (28.57%) readmitted for treatment of post-operative complication, 551 patients (21.18%) did not have a post-operative complication during the index admission. Only 192 patients (7.38%) had a post-operative complication during the index hospitalization and the readmission episodes of care. The data suggests that the presence of a post-operative complication during the index admission does not

increase the probability of readmission for a post-operative complication. Analysis of the data for Medicare only patients does not change the results.

Table 8.

Contingency Table comparing readmission reasons with presence of post-operative complications, All Payor.

	Readmission without post op complication	Readmission with post op complication
No Post Op complication (during index or during readmission)	Readmission without post op complication N = 1375 52.86%	Readmission d/t post op complication N = 551 21.18%
Post Op Complication (during either index admission or readmission)	Readmission without post op complication. Had post op complication during index visit N = 483 10.57%	Readmission with complication during INDEX and readmission N = 192 7.38%
Totals	Readmissions without post op complication N = 1858 71.43%	Readmissions with post op complication N = 743 28.57%

Discussion

The unplanned readmission rate for this study is 5.1% for all payors and 5.9% for Medicare. In effect, 1 in 20 patients are readmitted after THA or TKA. The study results are consistent with previous studies (Clement et al., 2013; Kiridly et al., 2014; Mednick, Alvi, Krishnan, Lovecchio, & Manning, 2014; Mesko et al., 2014; Pugely, Callaghan, Martin, Cram, & Gao, 2013; Schairer, Sing, Vail, & Bozic, 2014; Schairer, Vail, & Bozic, 2014; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2011; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2012). Hospitals with excessive 30-day readmission rates after TJA face a 3% financial penalty over their base Medicare reimbursement for

the TJA DRG, beginning with the FFY 2015 (Letourneau, 2014). MedPAC (Medicare Payment Advisory Committee) estimates that 75% of readmissions are avoidable (need citation). Many policy makers believe that readmission rate is a good indicator of quality care (Benbassat & Taragin, 2000). To develop suitable readmission avoidance strategies, healthcare providers must understand readmission reasons and risk factors.

This study described the characteristics of the TJA index population and the readmission population. Additionally, the investigation attempted to measure an association between post-operative complications and 30-day readmissions as well as an association between comorbid conditions and 30-day readmissions.

The data was also analyzed by payor source. Medicare was the largest payor source in the TJA population. The distribution of age, race, sex, presence of post-operative complications, and number of comorbidities per patient were mirrors of each other in the Medicare and the all payor groups. This does not help explain the difference in the readmission rates for the Medicare and all payor groups.

The primary reason for readmission in this study was not due to post-operative complications, but due to some other medical or surgical reason. Over half of the patients were readmitted without a diagnosis of post-operative complication during the index stay and the readmission. Specific readmission diagnoses were not individually described in this study.

An important study finding was related to the number of readmissions that had a post-operative complication during the index admission. Conventional logic would suggest that a post-operative complication during the index stay would increase the risk of readmission. The readmission rate for patients with a post-operative complication

during the index stay was 25.95%. However, the rate for readmission with a post-operative complication during both the index stay and the readmission was 7.38%.

During the data analysis, the frequency of each post-operative complication was not determined. A future study could assess the individual complications and the data could be used to develop improve care paths

Dementia was the most significant predictor of readmission, followed by Medicaid, congestive heart failure, and mental illness (including substance abuse). The dementia and Medicaid groups were small. The dementia rate was 1.3%. The Medicaid rate was 2.19%.

Patients with dementia may have difficulty in following specific post-operative instructions which could lead to hip dislocation, falls, and subsequent readmission. The severity of dementia is unknown for this patient population. Perhaps when ICD-10-CM diagnosis codes are implemented, levels of dementia will be available in administrative coded data. Further studies could be conducted to review medical necessity for TJA in patients with dementia. Physicians and administrators should not conclude that all dementia patients inappropriate candidates for TJA. Other factors such as pain and quality of life are significant considerations. Nevertheless, appropriate planning is necessary to minimize readmissions in patients who lack the ability to follow directions.

Patients with Medicaid may not have adequate socioeconomic resources to assure proper post-operative care. Developing programs to avoid readmissions, in these cases, may be more focused on the discharge plan and assuring proper psychosocial support systems.

Obesity was the most frequently occurring comorbid condition (17.46%) yet the regression analysis as a predictor of readmission was not statistically significant. Obese patients comprised 19.11% of the readmission group. Obesity has been documented in other studies as a contributing factor to surgical site infections and knee dislocations (cite reference).

The most important finding was the association between presence of comorbid conditions and readmission after TJA. The TJA population as a whole has a large number of comorbid conditions. We categorized the presence of comorbid conditions into “few” (0-3), “moderate” (4-6), and “high” (7+) number of comorbidities. Compared to a patient with few comorbidities, a patient with a moderate or high number of comorbid conditions present had between 27% and 78% increased chance of readmission. For every additional comorbid condition present, the patient has a 34% increased chance of readmission. This finding should suggest the importance of intraprofessional collaboration between the orthopaedic surgeon, primary care physician, hospitalist, and the hospital staff to assure that the patient is medically ready for surgery and has appropriate discharge plans. Pre-operative and post-operative patient education regarding the patient’s responsibility for his medical condition is imperative. The odds of readmission are higher in patients with COPD, CHF, and diabetes. In essence, modifying the risk of readmission through maximizing health status becomes more important for this elective procedure (Bronson et al., 2014).

Future access to care for TJA could become an issue. Medicaid patients have a higher probability of readmission after TJA. Patients with commercial insurance are 31% less likely to be readmitted. Age does not appear to be a predictor of readmission.

However, the odds of readmission for patients with commercial insurance are favorable and patients with this type of insurance are usually younger, employed and more literate. Is it possible that future patients will have decreased access to an orthopaedic surgeon because of the association between Medicaid insurance and odds of readmission? Providers and administrators should consider these results very carefully.

The results of this study must be interpreted in light of a few limitations. Much has been written about the validity and reliability of administrative data for readmission research. Administrative data in the United States uses the ICD-9-CM coding methodology. Coded data is primarily used for billing and reimbursement purposes. The accuracy of clinical coded data to reflect diagnoses, complications, and comorbidities has been challenged (Mears et al., 2002). However, the use of administrative data for this study is very relevant. Administrative coded data is used by CMS to determine all payment methodologies and penalties.

The ability to differentiate comorbid conditions from complications is but one limitation of administrative data (Cram, Bozic, Callaghan, Lu, & Li, 2014). However, upon examination of the reliability of administrative data as related to THA outcomes, Cram, Ibrahim, Lu, and Wolf (2012) determined that administrative data can be used to evaluate complications. Accuracy of administrative data is dependent on the clinical documentation as well as the coding skill (Bozic et al., 2010).

Conclusion

The findings reinforce the importance of thorough data review related to determining reasons for TJA readmissions. The current CMS readmission measures penalize hospitals for TJA readmission regardless of reason. The hospital is at financial

risk when patients with multiple comorbid conditions undergo the total joint arthroplasty procedure. Access to care is of utmost importance. Patients have a responsibility in maximizing their level of wellness.

Strategies to reduce readmissions should continue to include the usual and customary post-operative care and instructions. To further increase success with readmission reduction, strategies may need to include optimization of medical conditions prior to surgery (Weber & Greenberg, 2014). Optimization of wellness could be achieved through a formal pre-operative program offered by the hospital.

By 2019, the Affordable Care Act is expected to reduce CMS spending by approximately \$670 billion through reimbursement cuts and penalties. Reducing readmissions can have a huge impact on health care spending (Berwick & Hackbarth, 2012). The challenge is to develop public policy that does not have unintended consequences and limit access to care (Gu et al., 2014). Creating a generalized financial penalty for all readmissions suggests that every patient's baseline health status, demographic indicators, and risk of complications are equal (Mesko et al., 2014). Policymakers, physicians, and administrators have a duty to avoid limiting access to the TJA procedure on the basis that the patient poses a high risk of readmission. Our duty is to promote wellness and improve patients' quality of life.

Future Studies

The findings of this study provide substance for additional contributions to the body of knowledge regarding TJA readmissions. CMS continues to update expectations and methodology for reporting readmissions and complications. Commercial insurance providers are adopting the CMS quality reporting program.

Most hospitals have adopted the hospitalist model for provision of inpatient care. A study regarding the impact of the care provided by the hospital based physician during the index admission, as related to the management of comorbid conditions, could provide insight to a relationship between hospital management of chronic conditions and post-operative complications or readmissions. The results could motivate the development of a partnership between the surgeon and the hospitalist for improved management of chronic conditions.

Physician management of a post-operative complication or exacerbation of a chronic illness may occur in the emergency department. The emergency department physician can influence treatment decision making and patient disposition. A study regarding the effect of the emergency department care on readmission rate may redefine rationale for admissions from the emergency department.

In summary, health science researchers should continue to explore clinical and administrative data regarding TJA readmissions. Our goal is aligned with the Berwick's Triple Aim (Berwick, Nolan, & Whittington, 2008). Additional readmission research can drive better individual health, lower costs, and better health outcomes.

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Appendix A

List of Thirty-seven Procedures Qualified as Reasons for Planned Readmissions

- Percutaneous Transluminal Coronary Angioplasty (PTCA)
- Coronary Artery Bypass Graft (CABG)
- Heart valve procedures
- Aortic Resection; replacement or anastomosis
- Endarterectomy: vessel of head and neck
- Embolectomy and endarterectomy of lower limbs
- Peripheral vascular bypass
- Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator
- Cholecystectomy and common duct exploration
- Colorectal resection
- Other OR gastrointestinal therapeutic procedures
- Gastrectomy; partial or complete
- Inguinal and femoral hernia repair
- Amputation of lower extremity
- Arthroplasty knee
- Hip replacement; total and partial
- Arthroplasty other than knee or hip
- Spinal fusion
- Incision and excision of CNS
- Laminectomy; excision intervertebral disc
- Mastectomy
- Lumpectomy; quadrantectomy of breast
- Hysterectomy; abdominal and vaginal
- Oophorectomy; unilateral and bilateral
- Thyroidectomy; partial or complete
- Radical laryngectomy, revision of tracheostomy, scarification of pleura
- Transurethral resection of prostate (TURP)
- Open prostatectomy
- Lobectomy or pneumonectomy
- Nephrectomy; partial or complete
- Maintenance Chemotherapy
- Therapeutic radiology for cancer treatment
- Bone marrow transplant
- Kidney transplant
- Other organ transplantation
- Electroshock therapy

Adapted from Sacks, G. D., Dawes, A. J., Russell, M. M., Lin, A. Y., Maggard-Gibbons, M., Winograd, D.,...Ko, C. (2014). Evaluation of hospital readmissions in surgical patients. Do administrative data tell the real story? *Journal of American Medical Association*, 149(8), 759-764.

Appendix B

List of Sixty-six Diagnoses Qualified as Reasons for Unplanned Readmissions

- Septicemia/Shock
- Diabetes with acute complications
- Intestinal obstruction/perforation
- Other gastrointestinal disorders
- Other musculoskeletal & connective tissue disorders
- Iron deficiency & other unspecified hematological disorders
- Delirium and encephalopathy
- Coma, brain compression/anoxic damage
- Respirator dependence / tracheostomy status
- Cardio-respiratory failure & shock
- Acute myocardial infarction
- Heart infection/inflammation, except rheumatic
- Other heart rhythm & conduction disorders
- Ischemic or unspecified stroke
- Hemiplegia/hemiparesis
- Speech, language, cognitive, perceptual
- Vascular disease
- Aspiration & specified bacterial pneumonias
- Pleural effusion/pneumothorax
- End stage renal disease
- Renal failure
- Urinary obstruction & retention
- Decubitus ulcer of skin
- Severe head injury
- Concussion or unspecified head injury
- Hip fracture/dislocation
- Internal injuries
- Other injuries
- Major complications: medical care & trauma
- Major symptoms, abnormalities
- Other organ transplant/replacement
- Amputation status, lower limb/amputation
- Post-surgical states/aftercare/elective
- Disorders of fluid/electrolyte/acid-base
- Other endocrine/metabolic/nutritional disorders
- Peptic ulcer, hemorrhage, other specified gastrointestinal disorders
- Acute liver failure/disease
- Bone/joint/muscle infections/necrosis
- Coagulation defects & other specified hematological disorders
- Drug/alcohol psychosis
- Mononeuropathy, other neurological conditions/injuries
- Respiratory arrest
- Congestive heart failure
- Unstable angina & other acute ischemic heart disease
- Specific heart arrhythmias
- Cerebral hemorrhage
- Precerebral arterial occlusion & transient cerebral ischemia
- Diplegia (upper), monoplegia, & other paralytic syndromes
- Vascular disease with complications
- Other circulatory disease
- Pneumococcal pneumonia, emphysema, lung abscess
- Other eye disorders
- Dialysis status
- Nephritis
- Urinary tract infection
- Cellulitis, local skin infection
- Major head injury
- Vertebral fractures
- Major fracture- except skull, vertebrae, or hip
- Traumatic amputation
- Poisonings and allergic reactions
- Other complications of medical care
- Major organ transplant status
- Artificial openings (feeding or elimination)
- Amputation status, upper limb
- Other Infectious Diseases

Adapted from Sacks, G. D., Dawes, A. J., Russell, M. M., Lin, A. Y., Maggard-Gibbons, M., Winograd, D.,...Ko, C. (2014). Evaluation of hospital readmissions in surgical patients. Do administrative data tell the real story? *Journal of American Medical Association*, 149(8), 759-764.