Improving Quality and Decreasing Cost by Reducing Re-admissions in Patients Undergoing Total Joint Arthroplasty

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Abstract

Purpose of review Total joint arthroplasty (TJA) has had an increased demand over the recent years. It is a successful procedure, and there are relatively few complications, but there is a high overall cost. There is a push to increase the quality of care, lessen complications, and decrease cost by reducing readmissions. This article will discuss the risk factors that can contribute to the complication and readmission rates following TJA.

Recent findings Several risk factors have been found to contribute to the complication and readmission rates following a TJA. It is important to understand these risk factors and mitigate them as much as possible in order to optimize the patient experience. There are risk factors that cannot be modified, and the treatment team as well as the patient should be made aware of these and account for them when making the decision whether to undergo elective primary TJA or not. In general, an increased number of risk factors is associated with increased complications and increased readmission rates. At

our institution, we have used this knowledge to improve our outcomes and decrease costs.

Summary It is important to be mindful of risk factors for poor outcomes prior to performing TJA. This allows for the optimization of patients prior to undergoing surgery. This can lead to improved outcomes at a lower cost.

Keywords Total joint arthroplasty · Prevention of readmission · Modifiable risk factors

Introduction

Total joint arthroplasty (TJA) has enjoyed great success over the past several decades because of its predictable excellent results and relatively few complications. The increased demand for the procedure and the overall high cost has resulted in increased scrutiny of TJA for the Center of Medicare and Medicaid Services (CMS). The scrutiny of TJA by CMS has been with the purpose of further improving the quality of care and overall results, lessening the complications and providing this as cost savings to society. The purpose of this review is to provide information thereby helping surgeons and other health care providers prepare for the upcoming changes and improve patient outcome in a safe and cost-effective manner.

The greatest opportunity for improving outcome and providing savings in TJA is by focusing and successfully managing those patients at greatest risk for complications and readmissions. Many of the high-risk patients have comorbidities that increase their risk of complications and the likelihood of readmission. Several effective approaches are available to meet the needs of our patients and improve their outcomes in a cost-effective manner. The first approach is to identify the high-risk patients and to determine if they possess modifiable risk factors. If we can identify their risk factors preoperatively,

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then we can improve these risks. This will result in a relatively shorter hospital stay, greater likelihood of discharging the patients directly to home, and avoiding hospital readmissions. Risk factors can be either modifiable or non-modifiable. Several authors have identified modifiable risk factors such as morbid obesity, poorly controlled diabetes and nutritional deficiencies, *Staphylococcus aureus* colonization, tobacco use, venous thromboembolic disease, cardiovascular disease, neurocognitive, psychological, and behavioral problems, and physical deconditioning and fall risk [1•]. Non-modifiable risk factors include age, gender, race, socioeconomic status, diagnosed psychiatric disease, and other chronic disease processes such as chronic obstructive pulmonary disease (COPD) and chronic kidney disease (CKD). Research has been done to find strategies to optimize these patients prior to joint replacement surgery [2•].

This review will cover the risk factors that increase the rate of readmission, strategies to mitigate these risk factors, and our experience at our institution.

Risks

Modifiable Risk Factors

Obesity

The rate of obesity is a growing problem in the USA. According to the National Institute of Diabetes and Digestive and Kidney Diseases, the prevalence of obesity among adults in the USA has increased from 13.4 to 35.7% since the 1960s [3]. The problem of obesity has contributed to the increasing health care costs we are experiencing. Between 2005 and 2010, the aggregate medical costs for obese adults in the USA increased from \$212.4 billion to \$315.8 billion, an increase of 48.7% [4]. Obesity has been shown to lead to worse outcomes in TJA. There is significant evidence showing that obese patients are at an increased risk for postoperative complications, including infection, wound complication, and deep vein thrombosis (DVT) [5]. Factors that may contribute to higher infection rates include longer surgical times, difficult surgical exposure, decreased vascularization, and a weakened immune response [5, 6]. While there is no definitive BMI cutoff, systematic review of obese patients undergoing TJA suggests that a cutoff BMI of 40 will target patients with a significantly increased risk of complications [7]. One strategy to improve surgical risk in these patients is preoperative weight loss. This can be accomplished using surgical or non-surgical techniques. Bariatric surgery has consistently shown to improve the BMI of morbidly obese patients, but the clinical effects on subsequent TJA have been less clear. Severson et al. found that obese patients who underwent bariatric surgery more than 2 years prior to TKA had shorter anesthesia,

operative, and tourniquet times than those who did not undergo bariatric surgery prior to TKA. Unfortunately, there was not a statistically significant difference in 90-day complication rates, transfusion rates, or duration of hospital stay [8]. Here at UNMC, we counsel obese patients on the increased risks that they will face if they undergo TJA. We use a variety of strategies to help patients reduce their BMI including nutritional counseling, exercise programs, and medical versus surgical weight loss. Patients who need assistance with weight loss are referred either to a family practice physician who specializes in weight management or to the bariatric surgery program to facilitate weight loss.

Diabetes

Diabetes mellitus (DM) affects over 29 million people in the USA [9] and is a significant risk factor that increases the rate of perioperative complications in patients undergoing TJA [10]. Approximately 47% of people with DM have arthritis, and 8% of people undergoing TJA have DM [10, 11]. Patients with uncontrolled diabetes have a higher incidence of perioperative complications compared to controlled diabetic and nondiabetic patients [12]. Hemoglobin A1c has traditionally been used to predict the risk of surgical complications in diabetic patients. Marchant et al. found that patients who had uncontrolled DM, defined as a hemoglobin A1c greater than 7.0, had higher odds of stroke, urinary tract infection, ileus, postoperative hemorrhage, transfusion, wound infection, and death when compared to patients with controlled DM [12]. However, perioperative hyperglycemia has actually been shown to be a more accurate predictor of postoperative complications [13]. As such, it is important to maintain tight control of glucose levels in the perioperative setting. Anesthesia literature suggests maintaining a blood glucose level between 150 and 200 mg/dL intraoperatively and 140–180 mg/dL postoperatively [14]. Strategies to maintain appropriate blood glucose levels include utilizing diabetes education services preoperatively, avoiding dextrose-containing IV fluids, and involving a surgical co-management team in the postoperative care of the patient to assist with controlling blood glucose levels.

Malnutrition It has been found that patients who have inadequate nutrition are at a higher risk for readmission following TJA. Malnutrition has been defined by low serum albumin, total protein, transferrin, and/or total lymphocyte count. Although there is not a definitive cutoff in orthopedic literature, studies have used a serum albumin below 3.5 mg/dL to define malnutrition. Patients who are morbidly obese have a higher propensity to be hypoalbuminemic than patients who are not morbidly obese. However, regardless of BMI, patients who are hypoalbuminemic are at increased risk of complications. When compared to patients with normal albumin,

patients who have preoperative malnutrition had higher rates of postoperative complication, intensive care unit intervention, wound complications, septic complications, respiratory complications, return to the operating room, blood transfusions, extended length of stay, and 90-day readmission [15, 16•]. A serum albumin level may be obtained prior to surgery to assess for malnutrition. If a patient is found to have preoperative malnutrition, this can be modified before TJA with supplements to help decrease hypoalbuminemia perioperatively.

***Staphylococcus Aureus* Colonization** Twenty to thirty percent of the population are intranasal MSSA carriers, and 1–5% are carriers for MRSA [17]. Targeting *S. aureus* colonization has proven to be an effective surgical site infection (SSI) prevention scheme, as it causes significantly more SSI than other organisms [1•]. Preoperative decolonization has shown to decrease deep SSI by 13% [17]. Hewlett et al. found that the nares and oropharynx are the most common anatomic sites to be colonized with *S. aureus*. Thus, they are the best sites to screen prior to TJA [18]. If a patient's cultures are positive for MRSA or MSSA, they must undergo a decolonization protocol for 5 days prior to surgery. This includes applying 2% mupirocin in nares two times daily for 5 days. Using intranasal mupirocin preoperatively has been shown to have significant cost savings by reducing SSI [19]. Additionally, daily chlorhexidine showers for 5 days before surgery as well as daily laundering of clothing, towels, and bed linens are included in the protocol. Finally, patients are instructed to clean household surfaces with antibacterial cleaning solution and vacuum on days 0, 2, and 5. Perioperative prophylactic antibiotics should cover MSSA and MRSA for patients who were colonized [17].

Smoking

Approximately 21 to 24% of patients undergoing TJA in the USA are active tobacco users [20]. According to Moller et al. [21], tobacco use is the single most important risk factor for the development of postoperative complications. Complications which show a significant relationship to tobacco use include cardiopulmonary insufficiency, wound-related complications, revision surgery, prolonged hospitalization, postoperative admission to the ICU, and total number of days spent in the ICU [21]. Smokers have also been shown to accrue higher hospital costs than non-smokers. Lavernia et al. found that tobacco users accrued \$35,628 in hospital costs as opposed to \$30,706 for non-smokers [22]. Based on the proven increased risk of postoperative complications in smokers, it is important to implement a preoperative tobacco cessation program. Moller et al. [23] showed that preoperative tobacco cessation programs begun 6 to 8 weeks prior to surgery significantly reduced postoperative complications. This

program included education, counseling, and nicotine replacement therapy. It is important to note that the treatment group in this study included people who decreased their tobacco intake by 50%. Based on this study, we can conclude that a comprehensive preoperative tobacco cessation program is an important component of a preoperative TJA protocol.

Venous Thromboembolic Disease Patients who undergo TJA are at a high risk for postoperative DVT or subsequent pulmonary embolism (PE) complication [24]. Prophylaxis for these complications has reduced the rates of symptomatic DVT to <5% after THA and 20% after TKA. The rate of symptomatic PE has decreased to 1–2% after TJA with current thromboprophylaxis. Newer anticoagulants, including fractionated heparins, synthetic pentasaccharide, factor Xa, and direct thrombin inhibitors have shown efficacy in reducing VTED following TJA. However, they have been associated with an increased perioperative risk of bleeding and have not demonstrated a reduction in fatal PE. Alternatively, the more traditional chemoprophylactic agents, aspirin and warfarin, have increased incidence of residual clot but produced comparable clinical PE rates with a reduction in major bleeding complications [17]. It is imperative that the selection of a prophylaxis regimen aims toward a balance between hemorrhage and embolus and decreases the morbidity of bleeding while optimizing VTE prophylaxis to reduce PE and DVT [17, 25].

Cardiovascular Disease

Perioperative cardiovascular complications are a major cause of morbidity, mortality, and increased length of hospital stay for patients undergoing elective orthopedic procedures [26]. High preoperative cardiac risk can even increase the risk of non-cardiac complications in these patients [26]. It is important for patients to undergo a full cardiac workup prior to surgery if there is any suspicion of cardiac abnormalities. A workup may include an EKG, stress test, echocardiogram, or cardiac catheterization. It is also important for any necessary cardiac interventions to be done prior to undergoing surgery. Beta blockers have also been shown to have a beneficial effect in patients undergoing elective TJA. A study by Urban et al. [27] showed that postoperative prophylactic beta blockers were associated with a decreased incidence of postoperative myocardial infarction (MI).

Neurocognitive, Psychological, and Behavioral Problems

Studies have shown that patients with modifiable psychological risk factors have an increased rate of poor treatment adherence and poor outcomes after TJA. According to Ayers et al. [28], patients with higher trait anxiety, suboptimal use of coping skills, and mild depression had lower preoperative

Mental Component Score (MCS). These patients were more likely to have lower function, decreased pain relief, worse quality of life, and longer hospital stays after TJA [28, 29]. Studies have shown that pain management programs and cognitive behavioral therapy (CBT) improve coping skills, reduce the perception of pain, and decrease psychological disability [30, 31]. Based on these studies, it is reasonable to conclude that patients should be screened preoperatively for modifiable psychological risk factors and should undergo interventions if necessary. Patients do not need complete preoperative psychological assessments, but MCS is an effective screening tool to identify patients who are at higher risk for poor postoperative outcomes. Standardized pain management programs and cognitive behavioral therapy are both effective tools to improve these risk factors prior to surgery.

Physical Deconditioning and Comorbidities Affecting Ambulation

Physical condition and ambulatory status has been shown to be an important predictor of outcome following TJA [32]. Carpenter et al. [32] found that patients scoring worse on the activities of daily living hierarchy scale had longer hospital stays than those scoring better. It has been shown that preoperative physical therapy reduces the use of skilled nursing facilities, inpatient rehabilitation, and home health care services [33•]. This leads to an adjusted cost savings of \$1215 per patient episode. It is important for the orthopedic surgeon to identify patients preoperatively who may benefit from these services in order to reduce the use of post-acute care services in TJA patients.

Non-modifiable Risk Factors

There are many non-modifiable risk factors for readmission that must be taken into account when setting up patients for TJA. These can include age, gender, race, socioeconomic status, diagnosed psychiatric disease, and other chronic disease processes such as COPD and CKD [34•]. Even though it is impossible to eliminate these risks, it is important to understand them so they can be appropriately taken into account.

Demographics (Age/Gender/Race/Socioeconomic Status)

Patients over the age of 80 have been found to have higher rates of postoperative complications than younger patients after total joint replacement. Malkani et al. found that patients over the age of 80 have higher rates of dislocation, thromboembolic events, and readmission within 90 days [35]. Based on this information, it is important to ensure these patients are on an appropriate anti-coagulant regimen and are medically optimized throughout the perioperative period. Male sex has

also been found to be a risk factor for worse outcomes after surgery. Men have been found to have higher rates of surgical site infections and readmission within 30 days after surgery [36]. While this may not change practices, it is important to be mindful of all risk factors for worse outcomes.

Patients of minority or low socioeconomic status have been found to have worse outcomes after total joint arthroplasty. Singh et al. found that compared to Caucasian patients, African-Americans had longer hospital stays, higher readmission rates, higher rates of postoperative complications (infection, MI, and DVT/PE), and were less likely to be discharged home [37•]. Keeney et al. found that minority patients only show a significant decrease of 30-day readmission rate after risk reduction protocols if they are not of low socioeconomic status [38]. This suggests that there is a complex interplay between race and socioeconomic status in outcomes after total joint replacement. In these patients, it is important to focus on preoperative education, minimizing modifiable risk factors, and involving social work while in the hospital to ensure the situation to which the patient is being discharged is optimized.

Psychiatric Disease

Studies have shown that patients with depression and other psychiatric disorders have an increased risk of adverse outcomes and readmission after total joint arthroplasty [39, 40]. Klement et al. found that patients with psychiatric disorders such as bipolar disorder, schizophrenia, and depression were more likely to be younger and more medically complex. It was also found that these patients have an increased risk of postoperative complications such as infection, fracture, and extensor mechanism rupture. It is important to manage any modifiable comorbidities prior to operating on these patients. It is also important to use a multidisciplinary approach with psychiatry, psychology, and social workers to make sure these patients are managed most effectively.

Chronic Disease (CKD, COPD)

Chronic disease has been found to be associated with worse outcomes postoperatively after TJA [41•, 42•]. Tan et al. found that CKD greater than stage 2 is associated with increased length of stay, need for transfusion, and acute kidney injury, septic revisions, and in-hospital complications. It is imperative to avoid using nephrotoxic drugs perioperatively in these patients. It is also important to make sure to involve nephrology both preoperatively and perioperatively to make treatment recommendations. Bohl et al. [42•] found that COPD and DM are associated with increased rates of postoperative pneumonia. Risk reduction programs including nurse and patient education, aggressive pulmonary toilet, head of bed elevation to at least 30°, and ambulation with good pain control have been shown to reduce the risk of postoperative pneumonia.

Fig. 1 The graph shows our THA data for length of stay <2 days, readmission percentage, discharge to skilled nursing facilities, and average length of stay

Perioperative Risks for Readmission

There are many perioperative factors that have been found to be associated with an increased risk of readmission following TJA. These include surgeon volume, operative time, general anesthesia, use of anticoagulation other than aspirin, increased length of hospital stay, and discharge to an inpatient rehabilitation facility [43–47]. Kurtz et al. [44] found that increased

surgeon volume has a protective effect against readmissions after TJA. Each additional surgeon volume of 100 procedures leads to 6% less risk of readmission. Increased operative time has also been shown to increase the rate of readmission. A study by Ricciardi et al. [43] found that patients readmitted after THA and TKA had on average 9 min of increased operative time (84.4 ± 24.6 vs 75.0 ± 15.0 min) when compared to patients who were not readmitted. It is likely that surgeon

Fig. 2 The graph shows our TKA data for length of stay <2 days, readmission percentage, discharge to skilled nursing facilities, and average length of stay

experience and volume plays a role in decreasing operative time. Varacallo et al. [45] found that use of general anesthesia is an independent risk factor for 30-day readmission after TJA. This supports the practice of using spinal anesthesia. One study also showed that the use of anticoagulation other than aspirin is a risk factor for readmission [43]. It is likely that the choice of anticoagulation is related to the comorbidities of the patient. Patients at higher risk for DVT are more likely to be placed on other anticoagulants, while healthier patients may be more likely to be placed on aspirin. Increased length of stay has been shown to have a large impact on the risk of readmission after TJA. In a study by Williams et al. [46], hospital length of stay of greater than 4 days was found to nearly double the chance of readmission. This may be partially due to the fact that increased hospital length of stay can increase the risk of hospital-acquired infections and thromboembolic events. Lastly, multiple studies have shown that discharge to inpatient facilities is associated with worse outcomes and increased rates of readmission [43–47]. A study by Fu et al. [47] showed that discharge to inpatient facilities is independently associated with a higher rate of readmission and increased risk for a number of postdischarge complications. It was found that patients who were discharged to inpatient facilities had 1.9 times higher odds of readmission when compared with patients who were discharged home. Patients discharged to inpatient facilities were 2.3 times more likely to have septic complications. This can be devastating and is one of the most common reasons for readmission after TJA.

Our Experience

A retrospective review was done for patients who were readmitted following primary total hip arthroplasties and total knee arthroplasties done from July 2013 through January 2017. Factors reviewed included length of stay, discharge destination, days to readmission, reason for readmission, patient's BMI, preoperative *Staphylococcus* screening status, smoking status at time of readmission, smoking status less than 30 days before admission, coronary artery disease, stroke, peripheral vascular disease, VTED, CRCL, diabetes and whether HgbA1c was over 8 or well controlled, COPD, HTN, cancer, CHF, alcohol, narcotics, neurological deficit, physical functional impairment, and comorbidities affecting function.

During this time period, 435 patients underwent primary total hip arthroplasty, and 492 patients underwent primary total knee arthroplasty. Sixteen patients were readmitted, four patients were readmitted after total hip arthroplasty, and 12 patients who had undergone total knee arthroplasty were readmitted. Of the hip patients, two had been discharged home with home health service, one had been discharged to an inpatient

rehabilitation facility, and one had been discharged to a skilled nursing facility. Seven of the 12 patients who had TKA were discharged home with home health service, and five were discharged to a skilled nursing facility. The length of stay ranged from 2 to 11 days, with a mean of 3.69 days and a median of 3 days. The days to readmission ranged from 0 to 30. The average number of days from discharge to a skilled nursing facility to readmission for patients who underwent THA was 12.5, and for patients who underwent a TKA was 11.6. For patients who went home with home health care, the average number of days to readmission for THA patients was 9.5 and for TKA patients was 16.83. There was one patient who underwent TKA and was discharged home with no services who was readmitted after 1 day. BMI ranged from 24 to 47, with two patients whose BMIs were over 40, four patients with BMIs greater than 35 but less than 40, and seven patients who had BMIs from 30 to 35. One patient was colonized with MRSA preoperatively. No patients were smoking at time of surgery or for 30 days prior to surgery. Six patients had CAD, and one patient was on narcotic pain medication prior to surgery. All 12 patients who were readmitted had no history of stroke, cancer, PVD, or alcohol use. Four patients had VTED, two had COPD, and 13 had hypertension. Four patients had CHF, two patients had neurological deficit, one patient had physical function impairment, and two patients had comorbidities affecting function. There were four patients who had diabetes, three of which had HbA1c less than 5.5. One of the patients with diabetes was not well controlled with an HbA1c of 10.

One patient who was readmitted had none of these risk factors. Two patients had two risk factors, six patients had three risk factors, two patients had four risk factors, two patients had five risk factors, two patients had six risk factors, and one patient had seven risk factors. Reason for readmission varied widely among patients. These included altered mental status, hypoxia, hypertension, leg swelling, small bowel obstruction, wound dehiscence, cellulitis, acute kidney injury, nausea/vomiting, malaise, shortness of breath, sepsis and metabolic encephalopathy, hypertensive urgency, intramuscular hematoma, black out spells, quadriceps tendon rupture, and chest pain.

In this review, we also looked at overall length of stay, and the percentage of patients discharged in 2 days or less. As shown in the graphs below (Figs. 1 and 2), the average length of stay has decreased, the percentage of patients discharged to a skilled nursing facility has decreased, the percentage of patients who are discharged in less than 2 days has increased, and the overall readmission rate has not increased over the past 3.5 years.

Conclusion

Total joint arthroplasty is a highly successful procedure with good outcomes. Much research has been done regarding risk factors for poor outcomes and how best to optimize patients prior to surgery. Modifiable risk factors include obesity, diabetes, malnutrition, *Staph aureus* colonization, smoking, venous thromboembolic disease, cardiovascular disease, neurocognitive, psychological, and behavioral problems, and other comorbidities. Non-modifiable risk factors include age, gender, race, socioeconomic status, diagnosed psychiatric disease, and other chronic disease processes such as COPD and CKD. Perioperative risk factors include surgeon volume, increased operative time, general anesthesia, use of anticoagulation other than aspirin, increased length of hospital stay, and discharge to an inpatient rehabilitation facility. It is important to identify both modifiable and non-modifiable risk factors prior to surgery in order to best optimize these patients and improve outcomes. This will lead to reduced cost and lower readmission rates.

Compliance with Ethical Standards

Conflict of Interest Dr. Daniel Sveom and Mary Otteman declare that they do not have any conflicts of interest. Dr. Kevin Garvin serves as a board member, owner, officer, or committee member of the American Academy of Orthopaedic Surgeons, the American Orthopaedic Association, The Hip Society, The Knee Society, and Wolters Kluwer Health-Lippincott Williams & Wilkins.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- 34.9), obese II (35–39.9), and obese III (>40). The prevalence of malnutrition increased with BMI (6.1% in obese III vs. 3.7% in non-obese). Obese III was the only obesity class associated with any complication, wound complication, and reoperation. Hypoalbuminemia was found to be a stronger and more consistent independent risk factor, for any complication, wound, cardiac, or respiratory complications, and death.**
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