J Shoulder Elbow Surg (2016) ■■, ■■–■■

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

ORIGINAL ARTICLE

Analysis of complication rates following perioperative transfusion in shoulder arthroplasty

A. Jordan Grier, MD, Abiram Bala, MD, Colin T. Penrose, MD, Thorsten M. Seyler, MD, PhD, Michael P. Bolognesi, MD, Grant E. Garrigues, MD*

Department of Orthopaedic Surgery, Duke University Medical Center, Durham, NC, USA

Background: Postoperative anemia requiring a blood transfusion is not uncommon following anatomic total shoulder arthroplasty (TSA) or reverse total shoulder arthroplasty (RTSA). However, the potential complications in patients undergoing transfusion after shoulder arthroplasty remain unclear. The goal of this study was to examine the postoperative outcomes of patients receiving blood transfusions following TSA and RTSA.

Methods: Using the Medicare Standard Analytic Files database, we identified all patients undergoing TSA or RTSA between 2005 and 2010. Using *International Classification of Diseases, Ninth Revision, Clinical Modification* and Current Procedural Terminology codes, we identified the procedure, transfusion status, comorbidities, and postoperative complications of interest. Odds ratios and 95% confidence intervals were calculated.

Results: We identified 7,794 patients who received a perioperative blood transfusion following TSA or RTSA, as well as 34,293 age- and gender-matched controls, during the study period. Patients who received a perioperative transfusion had statistically significantly higher rates of myocardial infarction, pneumonia, systemic inflammatory response syndrome or sepsis, venous thromboembolic events, and cerebrovascular accidents at all time points in question. Patients who received a blood transfusion also showed an increased incidence of surgical complications, including periprosthetic infection and mechanical complications, up to 2 years postoperatively.

Conclusion: To our knowledge, this represents the largest study to examine the relationship between the need for perioperative blood transfusion and postoperative medical and surgical outcomes following TSA and RTSA. The results observed in this study highlight the importance of preoperative counseling and medical optimization prior to shoulder arthroplasty, particularly in patients with preoperative anemia or multiple medical comorbidities.

Level of evidence: Level III; Retrospective Cohort Design Using Large Database; Treatment Study

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Keywords: Total; shoulder; replacement; arthroplasty; reverse; transfusion; complications; database

The use of shoulder arthroplasty for relief of pain, improved motion, and improved shoulder function in patients with glenohumeral osteoarthritis has risen considerably for several decades.[32,49,57] Improvements in implant design and surgical technique have allowed for improved outcomes and broadening of the indications for which shoulder arthroplasty

This study was deemed exempt research by the Duke Medicine Institutional Review Board for Clinical Investigations.

*Reprint requests: Grant E. Garrigues, MD, Department of Orthopaedic Surgery, Duke University Medical Center, Box 3639, Durham, NC 27710, USA.

E-mail address: grant.garrigues@gmail.com (G.E. Garrigues).

1058-2746/$ - see front matter Published by Elsevier Inc. on behalf of Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2016.11.039

is now applicable. Anatomic total shoulder arthroplasty (TSA) has been shown to provide excellent intermediate- to long-term results for patients with glenohumeral arthritis and an intact rotator cuff.[15,16,19,30,44,60] Reverse total shoulder arthroplasty (RTSA) has also become increasingly prevalent as the indications for its use continue to expand. Initially conceived as a treatment option for patients with a deficient rotator cuff and concomitant glenohumeral arthritis, referred to as *cuff tear arthropathy*, the indications for RTSA have expanded to include use in the treatment of acute and chronic traumatic shoulder injuries, reconstruction after oncologic resection, management of arthritis in patients with severely eroded glenoids, and failure of prior anatomic TSA.[4,26,50,59]

Although the incidence of surgical complications following TSA and RTSA has been previously described in the literature, the perioperative medical complications of shoulder arthroplasty are an infrequent topic of investigation and discussion.[6,11,12,29,61,62] The hip and knee arthroplasty literature provides excellent insight into the incidence of perioperative morbidity and mortality observed in these patient populations; however, by comparison, this evidence is relatively lacking in the shoulder arthroplasty literature.[2,58] The incidence and impact of allogeneic packed red blood cell transfusion have garnered particular interest in recent years, particularly in the hip and knee, where allogeneic packed red blood cell transfusion has been linked with an increased risk of multiple perioperative complications including periprosthetic infection, venous thromboembolic events, and pneumonia.[39,41,48] In the setting of shoulder arthroplasty, however, the full impact of blood transfusion remains undetermined. Perioperative transfusion following either TSA or RTSA has been reported to occur in 4.3% to 43% of patients.[1,23,24,35,47,51,54] Previous reports on the impact of risk factors such as age, obesity, and gender on the incidence of transfusion have aided in the understanding of those patients who may go on to require blood transfusion; however, the potential impact of need for transfusion on both perioperative medical and surgical outcomes in the shoulder arthroplasty population remains unclear. The aim of this study was to examine the incidence of complications associated with perioperative transfusion at multiple time points postoperatively in a large cohort to further describe short-term outcomes of patients receiving transfusions following shoulder arthroplasty. We hypothesized that, similar to hip and knee arthroplasty patients, patients undergoing shoulder arthroplasty with red blood cell transfusion in the perioperative period would have a higher rate of complications than age- and gender-matched controls.

Materials and methods

Using the services of PearlDiver Technologies (West Conshohocken, PA, USA), we queried the entire 2005 to 2012 Medicare Standard Analytic Files database containing over 51 million unique patient records. The data recorded in this database are populated from administrative coding records including all Current Procedural Terminology (CPT) and *International Classification of Diseases, Ninth Revision* (ICD-9) codes used for billing purposes during the patient's surgical encounter. Using *International Classification of Diseases, Ninth Revision, Clinical Modification* and CPT codes, we identified the procedure, transfusion status, comorbidities, and postoperative complications of interest. In the PearlDiver Technologies program, for compliance with the Health Insurance Portability and Accountability Act, all patient cohorts between a value of 1 and 10 return as a null value.

We identified all patients who had TSA and RTSA using ICD-9 procedure codes 81.80 and 81.88 and CPT code 23472. This code selection allows for all patients undergoing TSA or RTSA to be identified but does not allow for the ability to discern whether this was a primary or revision shoulder arthroplasty. This code selection also does not allow for the identification and subsequent exclusion of those patients undergoing bilateral, simultaneous shoulder arthroplasty. To the best of our ability, we excluded those patients undergoing revision arthroplasty by excluding ICD-9 code 81.97 used for revision of joint replacement of the upper extremity. The PearlDiver Technologies command language was used to identify those patients who received either allogeneic or autologous red blood cell transfusions by use of ICD-9 procedure codes 99.0, 99.00, 99.02, 99.03, and 99.04 and CPT code 36430 during the same admission as their TSA or RTSA and then an age- and gender-matched control group of patients who received no blood transfusions in the perioperative period for their TSA or RTSA. This code selection allows for all patients undergoing a perioperative blood transfusion that was documented in the medical record to be identified but does not allow for the ability to distinguish whether patients received an allogeneic or autologous blood transfusion. In this study, a "perioperative blood transfusion" refers to a transfusion occurring during the same admission as the index arthroplasty procedure. This includes the immediate preoperative period following admission to the preoperative anesthesia care unit until the time of discharge following surgery. We included only patients who underwent the procedure between 2005 and 2010 to ensure a minimum 2-year follow-up per patient. Comorbidity information for each group was obtained including both the Charlson Comorbidity Index (CCI) score and the prevalence of 30 Elixhauser comorbidities. The 30 Elixhauser comorbidities were collected from the Medicare database using ICD-9 codes. Patients were considered to have the comorbidity if they had the corresponding code at any time point in the database prior to the surgical admission. The presence of blood loss anemia and presence of deficiency anemia comorbidities were assessed using separate ICD-9 codes from each patient's medical record, and these were considered to be separate comorbidities in this study. The CCI, a method of predicting 1-year mortality of patients on the basis of their relative degree of comorbidity as determined by the *International Classification of Diseases* diagnosis codes found in their health record, has been validated as a method for predicting morbidity and mortality in large administrative inpatient datasets.[10,14,34,37,55] The Elixhauser method has also been validated in large inpatient datasets as a means of using a specific set of *International Classification of Diseases* diagnosis codes to describe in-hospital mortality and hospital resource use.[13,18,52,63]

Postoperative medical and surgical complications were determined using a combination of Centers for Medicare & Medicaid Services (CMS) codes, complications found in similar database studies, and the experience of our institution's fellowship-trained shoulder and elbow surgeons. We evaluated 7-day CMS complications, as well as select 30- and 90-day medical complications. We evaluated surgical complications at 90 days and 2 years postoperatively. In this