Process Improvement Project Using Tranexamic Acid Is Cost-Effective in Reducing Blood Loss and Transfusions After Total Hip and Total Knee Arthroplasty

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ABSTRACT

Background: Tranexamic acid (TXA) has been associated with decreased blood loss and transfusion after total hip arthroplasty (THA) and total knee arthroplasty (TKA). The purpose of this study was to examine both transfusion utilization and the economic impact of a Process Improvement Project implementing TXA for THA and TKA.

Methods: After standardization of TXA administration in THA and TKA patients, retrospective data were compared from 12 consecutive months before (group A, n = 336 procedures) and after (group B, n = 436 procedures) project initiation.

Results: TXA administration increased with project implementation (group A = 3.57%, group B = 86.01%) and was associated with reductions in perioperative hemoglobin decrement (20.2%), patients transfused (45%), and number of units transfused per patient (61.9%). Cost savings were notable per patient ($128) and annually program wide ($55,884) with the primary THA subgroup contributing the most to the savings. No increase in adverse effects was observed.

Conclusion: Standardized administration of TXA is an effective and economically favorable blood-reduction strategy for patients undergoing elective THA or TKA. Although reduction in transfusions with TXA may be greater after TKA, the economic and clinical impact of transfusion reduction is more substantial in THA patients.

Perioperative surgical bleeding is a serious concern in many types of surgery, including total joint arthroplasty (TJA). Intraoperative bleeding and post-surgical hemorrhage can lead to detrimental consequences and complications such as acute blood loss anemia, increased length of stay, delayed recovery, hematoma, infection, and death in rare circumstances. Transfusion of packed red blood cells (PRBC) is advantageous in restoring oxygen-carrying capacity and replacing intravascular volume but is associated with the risks of transfusion reactions, antigen exposure, disease transmission, immunosuppression, and infection [1–3]. In addition to patients’ risk, bleeding and subsequent transfusion are associated with increased health care costs attributed to blood product acquisition and increased level of care [4–6].

Blood conservation and transfusion reduction strategies have been widely used in TJA to improve the quality of care and reduce the costs associated with these increasingly popular procedures. Preoperative strategies include cessation of medications associated with bleeding along with assessment and treatment of preoperative anemia. Intraoperative strategies include the use of a tourniquet when appropriate, hypotensive anesthesia, regional anesthesia, avoidance of hypothermia, blood salvage, meticulous hemostasis, and hemostatic agents. Postoperative measures include reduced phlebotomy, use of compressive dressings and reinfusion drains, cautious chemoprophylaxis for venous thrombosis, and alteration of transfusion triggers. More recently,
intravenous antifibrinolytic agents have been used to reduce blood loss and transfusions without a significant increase in perioperative complications.

Tranexamic acid (TXA) is a synthetic analog of the amino acid, lysine. It exhibits antifibrinolytic activity by reversibly blocking the lysine-binding site on plasminogen, thus, competitively inhibiting plasminogen or plasmin binding to lysine residues on fibrin. This prevents the degradation of fibrin and stabilizes blood clots [7–11]. TXA was first used in cardiothoracic surgery 40 years ago and has since been described in other high blood loss scenarios, including acute trauma and gynecologic hemorrhage [7,12,13]. In addition, the efficacy and safety of TXA for TJA have been evaluated in several recent studies and meta-analyses [14–31]. In general, the drug is administered through either a topical or intravenous (IV) route during TJA procedures.

Published data indicate that the use of TXA in TJA is effective in reducing blood loss and transfusion requirements [14–23,30,32–36]. However, comparisons have not been made among the different types of TJA, that is, total hip arthroplasty (THA) vs total knee arthroplasty (TKA), and primary vs revision surgeries. Furthermore, past research has focused on patient well-being with limited evaluation on the economic impact to patients and hospitals. The present study (1) evaluates standardization of TXA administration in TJA patients through a hospital-initiated Process Improvement (PI) Project, (2) compares the efficacy and safety of TXA use in TJA, and (3) aids in developing a strategy for implementing TXA use in TJA. We hypothesize that a PI Project using IV TXA in a standardized protocol improves the frequency of medication administration in TJA patients and is associated with reduced blood loss, fewer transfusions, and decreased hospital costs.

Materials and Methods

A standardized protocol for administration of TXA in patients undergoing THA and TKA was initiated as a PI Project and implemented by a multidisciplinary Total Joint Quality and Process Improvement (TJ-QAPI) Committee at a single institution on November 1, 2013. The TJ-QAPI Committee consisted of representatives of several constituencies including orthopedic surgeons, anesthesiologists, perioperative nurses, pharmacists, managers, therapists, data analysts, and infection-control personnel. For ease of implementation, the PI protocol set the TXA dosage as 20 mg/kg, with a maximum of 2 g, via IV administration. TXA was administered by anesthesia personnel within 30 minutes of the anticipated surgical bleeding—before skin incision for THA and before tourniquet deflation for TKA. All TJA patients were candidates for TXA; however, TXA could be withheld if the surgeon or anesthesiologist determined an elevated risk of thromboembolic disease or coronary stent thrombosis.

Pooled patient data regarding the number of patients, the hospital length of stay, perioperative decline in hemoglobin, transfusion rates and units of blood transfused, compliance with transfusion guidelines, complications, and readmissions were monitored monthly by the TJ-QAPI Committee as a component of the PI Project. Prospective data from November 1, 2013, to October 31, 2014 (post-TXA, group B), were compared with data collected the previous year, November 1, 2012, to October 31, 2013, before standardized TXA implementation (pre-TXA, group A). No other blood management strategies and transfusion triggers were changed during the Project period. Four orthopedic surgeons participated in the program. Patient data were analyzed to compare variables from the year before Project initiation (group A) to the year after initiation (group B).

After completion of the PI Project and institutional review board approval, further data collection on individual patients (nonpooled) was initiated. Written, informed consent was waived by the institutional review board. Patient data were collected by a blinded third-party data analyst. Examined data included date of the surgery with respect to the initiation of the PI Project, the type of procedure, length of hospital stay, perioperative and postoperative hemoglobin levels, units of blood transfused, complications, readmissions, and demographic information (age, gender, weight, height, and body mass index). A power analysis was not necessary before the initiation of the review of individual outcomes because the prospectively collected pooled quality data indicated significant differences in most primary outcome measures. Moreover, expanding the study group would have introduced other variables including transfusion triggers, drain use, and additional surgeons.

Data analysis was performed with IBM SPSS Statistics for Windows, version 23 (Armonk, NY). Data normality was assessed with the Shapiro-Wilk test. Independent t test analyses were performed for pre-TXA protocol vs post-TXA protocol for (1) all TJA combined, (2) primary and revision TKAs, (3) primary TKA, (4) revision TKA, (5) primary and revision THAs, (6) primary THA, and (7) revision THA. The following were evaluated for each of the major hypotheses tested: (1) administration of TXA, (2) hemoglobin loss, (3) transfusion rate/units of PRBC, and (4) complications/readmissions. Dichotomous variables were compared with the chi-square test. Alpha was originally set at 0.05; however, because there were 4 distinct major hypotheses tested, the original alpha was divided by 4 to reduce the risk of type I statistical error (Bonferroni); therefore, alpha was set at 0.0125.

Results

There were 336 patients in group A and 436 patients in group B. Cases examined included 48% primary TKA, 36% primary THA, 8% revision THA, and 8% revision TKA. There were no statistically significant differences in patient age, gender, body mass index, preoperative hemoglobin, or length of stay between the 2 groups (P > .0125). Demographic information is summarized in Table 1. In both groups combined, length of stay was increased for patients requiring a blood transfusion, by an average of 2.28 days (transfused, 5.11 days; nontransfused, 2.83 days; P < .001).

Administration of IV TXA in TJA patients increased from 3.57% to 86.01% after implementation of the protocol (P = .001; Fig. 1). Overall perioperative hemoglobin decline was reduced by 20.2% (group A, 3.08 g/dL; group B, 2.46 g/dL; P = .001); this improvement was statistically significant in all groups except revision THA (Fig. 2) and translated into a 45% reduction in the number of patients requiring a blood transfusion (16.67% vs 9.17%; P = .002; Fig. 3). Subgroup analysis revealed a significant reduction in transfusion rate for primary TKA (7.7% vs 10%; P = .012), all TKA (7.4% vs 2.1%; P = .008), and primary THA (25.2% vs 12.3%; P = .005). Revision THA (P = .028) and all TKA (P = .016) subgroups did not reach statistical significance after Bonferroni correction of the P value. In aggregate,
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