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Cost Benefit Analysis of Topical Tranexamic Acid in Primary Total Hip and Knee Arthroplasty

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ABSTRACT

The purpose of this study was to provide a cost–benefit analysis of topical tranexamic acid (TXA) in primary total hip and knee arthroplasty patients. A retrospective cohort of 591 consecutive patients, 311 experimental and 280 control, revealed a transfusion rate reduction from 17.5% to 5.5%, increased postoperative hemoglobin, and decreased delta hemoglobin without an increase in adverse events (all $P<0.001$). This led to saving $83.73 per patient based on transfusion costs alone after accounting for the cost of TXA. Hospital disposition to home compared to subacute nursing facility was also significantly increased by 9.3% ($P<0.02$). We conclude that topical TXA reduces transfusion rate, increases home disposition, and reduces cost in primary hip and knee arthroplasty.

With growing public scrutiny for the provision of ever more efficient and effective health care, orthopaedists bear increasing pressure to minimize costs yet maintain quality care. The reduction of perioperative blood transfusions in total joint arthroplasty has been an ongoing effort with this goal in mind. Perioperative transfusion adds both cost to the procedure and risk to the patient, including joint infection, allergic reaction, and viral transmission [1–3]. This has led us to analyze the cost benefit ratio of topical tranexamic acid (TXA) in primary hip and knee arthroplasty.

Tranexamic acid is a synthetic derivative of the amino acid lysine which produces antifibrinolytic activity by competitively inhibiting lysine binding sites on plasminogen molecules. Through this process, it is believed that TXA is able to help the body retain blood clots more effectively and thereby reduce bleeding.

Several recent studies have sought to elicit the clinical outcomes of TXA in total joint arthroplasty. Most protocols have involved intravenous delivery of TXA, revealing impressive results [4,5]. An oral form of TXA has also been shown to be effective [6]. While these studies have not shown adverse events caused by TXA such as increased thromboembolic events, this continues to be a concern, and is perhaps why TXA implementation has been slow to progress. A growing number of studies indicate that intraarticular injection or topical administration may provide some advantages; these include potentially reduced costs with a single injection, surgeon control, and localization and concentration of the drug to the surgical site. Topical application increases efficacy where it is intended as well as reduces possible side effects by minimizing systemic exposure. Recently published studies have shown decreased transfusion rates and reduced swelling with topical TXA in total knee arthroplasty without increased complications [6–8].

The primary goal of this study was to determine whether initiation of topical TXA in total hip and knee arthroplasty at our institution has reduced transfusion rates, reduced costs, altered complication rates, and reduced hospitalization times. The secondary goal was to provide a description of an effective method for topical TXA administration in total hip and knee arthroplasty.

Materials and Methods

Following IRB approval, 591 primary, consecutive total joint arthroplasties performed by 5 orthopaedic surgeons at a single institution between March 2012 and March 2013 were retrospectively reviewed. September 1st 2012 marked the day that each of these surgeons began to administer topical TXA to all total joint patients intraoperatively. The months of August and September of 2012 were excluded from the study to prevent overlap of the experimental and control groups. The proportion of patients was similar between the two cohorts for each surgeon. Bilateral total joints, revision joints, and fractures requiring arthroplasty were excluded from the study.

Patients underwent either spinal, regional block or general anesthesia as determined on a case by case basis. Patients received local 0.5% Marcaine without epinephrine at the operative site after wound closure. All patients received preoperative antibiotics within 1 h of surgical incision, typically cefazolin, vancomycin if MRSA history present, or clindamycin if significant cephalosporin allergy.

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For TKA, following release of the tourniquet, electrocautery was used to achieve hemostasis. Capsular closure was then performed. One gram of TXA in 10 cc of normal saline was injected intraarticularly in total knees. For THA, one gram of TXA in 10 cc of normal saline was injected in the pericapsular and deep tissue spaces or intraarticularly following iliotibial band or tensor fascia closure depending on the surgeon's preference. Multi-modal postoperative DVT prophylaxis was used including thromboembolism-deterrent stockings, sequential compression devices, and chemical prophylaxis. One surgeon used postoperative aspirin for chemical DVT prophylaxis while the other four used Coumadin. No intraoperative drains were placed. No changes were made to each surgeon's individual surgical and postoperative protocols between the control and experimental groups. No primary, unilateral total joint patients were excluded from TXA use. Transfusion was triggered by a hemoglobin of less than 8 g/dL or symptomatic anemia for all patients in both control and experimental groups.

Each chart was reviewed via the electronic medical record and the following variables were obtained: age, gender, BMI, transfusions, preoperative hemoglobin, postoperative hemoglobin, operative time, tourniquet time, days in hospital, 30 day readmission, disposition to home or subacute nursing facility, and complications including UTI, MI, DVT, stroke and death. No routine screening for DVT/PE was performed. Symptomatic DVT was confirmed by ultrasound.

The blood transfusion cost was estimated using prior published data [9] and confirmed with our hospital Blood Bank. Transfusion cost per 1 U RBC was estimated to be $726 in 2008 at our institution. Adjusted for inflation, this cost was $787.37 in 2013. The cost of 1 g of TXA was approximately $58 in 2013 at our institution. Preoperative hemoglobin was obtained within 30 days of surgery. Postoperative hemoglobin was obtained daily while the patient was hospitalized; the lowest hemoglobin was recorded for analysis. Readmissions within 30 days were recorded regardless of indication.

Statistical analysis was used to confirm the significance of the results. The chi square test was used for discrete variables such as transfusion rate and hospital disposition. Independent t-tests were used for continuous variables such as drop in hemoglobin, BMI, age, etc. Statistical significance was defined as $P < 0.05$.

Results

There was no statistically significant difference in demographics between the pre and post TXA groups. The control group (280 patients) consisted of 169 TKA and 111 THA; TKA made up 60.4% of the control group cases. The experimental TXA group (311 patients) consisted of 185 TKA and 126 THA; TKA made up 59.5% of the experimental group cases. Demographics are summarized in Table 1. This shows a nearly identical patient population in terms of gender, age, BMI, preoperative hemoglobin, and surgical procedure.

The preoperative hemoglobin levels were similar with the control group being a mean of 13.7±1.38 g/dL and the TXA group being 13.9±1.44 g/dL. There was a significant difference in postoperative hemoglobin however, with the control group being 9.17±1.25 g/dL and the TXA group being 10.0±1.33 g/dL ($P < 0.0001$ as calculated by independent t-test). The resultant delta hemoglobin values are 4.5 g/dL and 3.9 g/dL for control and TXA groups, respectively ($P < 0.0001$).

Chi square analysis reveals a significant difference in number of RBC units transfused between the groups. The control group required 80 U RBC for 280 patients to be transfused while the TXA group required only 33 U for 311 patients. That is 10.6% units transfused after TXA implementation down from 28.6% prior, a reduction of 18% ($P < 0.001$). Of the 80 U transfused in the control group, 39 U went to THA patients (48.8%). In the TXA group, 13 U of the 33 U (39.4%) went to THA patients. While a relatively larger number of RBC units went to THA in the control group, this result was not significant ($P > 0.5$). The control group required 49 patients to be transfused. The TXA group required 17 patients to be transfused. That is a 17.5% transfusion rate reduced to 5.5%, a reduction of 12% ($P < 0.001$).

Chi square analysis was applied to show a significant difference in post hospital disposition. In the control group, 174 of 280 patients (62.1%) went home as opposed to subacute nursing facility. In the TXA group, 222 of 311 patients, (71.4%) went home, $P < 0.02$.

Tourniquet time, operative time, and time in room averaged 54, 101.2, and 139.7 min respectively for the control group. Tourniquet time, operative time, and time in room averaged 64.7, 121.5, and 140.8 min respectively for the TXA group. The difference was not statistically significant. Number of days in the hospital remained nearly the same between each group. The control group averaged 3.16 ± 0.75 days while the TXA group averaged 3.15 ± 1.12 days ($P = 0.93$).

Adverse events were similar between each group. The control group experienced 2 UTIs and 1 symptomatic DVT in the 30 day postoperative period. The TXA group suffered 1 UTI and 1 MI. Twelve patients in the control group were readmitted within 30 days while 13 were readmitted in the TXA group. No patient in either group required reoperation in the 30 day postoperative period for any reason, including infection or hematoma evacuation. Primary outcomes are available in Table 2.

Cost analysis was based solely on transfusion rate reduction. With a transfusion cost of $787.37 and a 1 g of TXA cost of $58, there was a savings of $8372.66 per 100 arthroplasty patients treated. In full

Table 1
Demographics.

	No TXA (N = 280)	TXA(N = 311)	*P* Value
Age (years)	66.1±11.26	65.2±10.55	0.33
Male	113	131	>0.5
Female	167	180	>0.5
Total Hip	111	126	>0.5
Total Knee	169	185	>0.5
BMI	31.5±6.3	31.5±6.5	0.91
Preoperative Hgb	13.7±1.38	13.9±1.44	0.12

Data reported as mean ± SD or total sum. *P* values calculated using either independent T-test or chi square test.

Table 2
Primary Outcomes.

	No TXA (N = 280)	TXA (N = 311)	*P* Value
Length of stay (days)	3.16±0.75	3.15±1.12	0.84
Disposition home	174	222	<0.02
Disposition SNF	106	89	<0.02
Readmission	12	13	>0.5
Complications	3	2	>0.5
Postoperative Hgb	9.17±1.25	10±1.33	<0.001
Delta Hgb	4.5±1.11	3.8±1.31	<0.001
Patients transfused	49	17	<0.001
Units Transfused	80	33	<0.001

Data reported as mean±SD or total sum. *P* values calculated using either independent T-test or chi square test.

Table 3
Transfusion Financial Summary.

	No TXA (N = 280)	TXA (N = 311)	Difference
Total transfusion cost (USD)	$62,989.60	$25,983.21	$37,006.39
Transfusion Cost for TKA	$32,282.17	$15,747.40	$16,534.77
Transfusion Cost for THA	$30,707.43	$10,235.81	$20,471.62
Units Transfused (%)	28.6%	10.6%	18%
Transfusion Cost per 100 pts	$22,518.78	$8346.12	$14,172.66
Patients Transfused	17.5%	5.5%	12%
Cost per patient	$225.19	$141.46	$83.73

United States Dollar (USD). Transfusion cost assumes $787.37 per unit PRBC. TXA cost assumes $58 per 1 g.