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Transfusion Cost Savings with Tranexamic Acid in Primary Total Knee Arthroplasty from 2009 to 2012

Joseph T. Moskal, MD [a], Ryan N. Harris, DO [a], Susan G. Capps, PhD [b]

[a] Virginia Tech Carilion School of Medicine, Roanoke, VA
[b] BENSOL, Warsaw, IN

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ABSTRACT

Tranexamic acid (TXA) has proven to be very advantageous to the total knee arthroplasty (TKA) population. With TXA, the need for allogeneic blood transfusion is reduced and thus hospital costs are reduced. In our hospital system, before TXA was used, facility cost was an estimated $84.90/TKA for blood transfusion and required 0.13 man-hours/TKA (transfusion rate 6.5%); after incorporating intravenous TXA, cost was $82.59/TKA for blood transfusion and TXA medication and 0.007 man-hours/TKA (transfusion rate 0.3%). There were no transfusions when TXA was applied topically, and the facility cost was $39.14/TKA and no employee hours consumed. Topical TXA has the potential to significantly reduce blood transfusions and decrease hospital man-hours/TKA as well as achieve larger cost saving.

Tranexamic acid (TXA) is a plasminogen-activator that has been used widely in many surgical specialties to help reduce the need for allogeneic blood transfusions. TXA therapy has been applied to total joint arthroplasty with similar reduction in transfusion rates [1–12]. There are also several risks secondary to blood transfusion that are reduced or removed when TXA is employed: transfusion reactions, infections, fluid overload and altered mental status; all of which may lead to prolonged hospitalization [1,4,10,13]. The financial impact of TXA could be very important to TKA due to changes in health-care economics.

There are a number of publications that address costs associated with topical-TXA versus no-TXA in TKA populations [1,3,4,7,9,14]. The drug cost of topical-TXA varied from as little as $6 in some countries to $80 at some U.S. locations [3,7,15]. Other authors looked at pharmacy cost, blood bank cost, and total direct cost of topical-TXA in primary TKA [1,4,7,14]. Pharmacy cost was higher in topical-TXA TKA patients than in no-TXA TKA patients [1]. Blood bank cost was lower in topical-TXA TKA than in no-TXA TKA [1,7]. Total direct cost was lower in topical-TXA than in no-TXA TKA [1,4,7,14].

We have chosen to ask two questions of a clearly defined, comparative dataset: (1) Does TXA in TKA result in reduced facility costs (the cost of TXA and the cost of allogeneic blood transfusion expressed in dollars per TKA) and (2) Does TXA in TKA result in reduced man-hour costs (the time needed to successfully deliver a unit of blood and to address possible transfusion reactions and/or any other untoward effects.).

Materials and Methods

This is a case-control study of a population originally complied by Wind et al for a study of transfusion rates comparing TXA usage in total knee arthroplasties (TKAs) [11]. From 2009 to 2012, four surgeons at a single institution performed all of the TKA in this study. One surgeon adopted the protocol initially; 6 months later two additional surgeons adopted the protocol; and 6 months after that (12 months since inception) a fourth surgeon adopted the protocol; all four surgeons involved in this analysis were fellowship trained in adult reconstruction at this tertiary care center. Pre-operatively, there was no additional intervention, such as Procrit or iron supplementation, for patients at a high risk of blood transfusion. Post-operatively, all patient drains were clamped for 30 minutes. Patient records were reviewed and TKA patients were categorized to one of three groups (no-TXA, IV-TXA, and topical-TXA).

Wind et al identified patients through chart review of TKA performed between 2009 and 2012 [11]. Patients were not randomized; allocation was dependent on date of TKA (earlier TKA were performed without TXA) and on cardiovascular and thromboembolic health status (IV-TXA and topical-TXA). Patients who did not receive TXA were designated as "controls" (no-TXA, $n = 1839$). Patients who received TXA during the course of surgery were defined as "cases" and were subdivided into IV-TXA ($n = 330$) or topical-TXA ($n = 130$). There were no significant differences in demographics or pre-operative matocrit between groups (Tables 1 and 2) [11].

IV-TXA was administered as 1-gram infusion within 1 hour of incision with an additional gram administered as wound closure began [11]. The topical-TXA group is made of patients who had a heart attack within the previous 6 months, who had a stent placement within the previous 12 months, or who had a previous embolic event [11].

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Reprint requests: Susan G. Capps, Ph.D, BENSOL, 488 East Bell Drive, Warsaw, IN 46582.

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Table 1
Demographic Information for Male Patients ($n = 952$) (reprinted from Wind et al [11]).

	Age	Height	Weight (lb)	BMI
No-TXA, mean (range)	66 (31–94)	5′9″ (5′1″–6′7″)	226 (129–460)	32.1 (19.3–61.8)
IV-TXA, mean (range)	65 (40–89)	5′9″ (5′3″–6′6″)	221 (150–355)	31.2 (23.1–48.3)
Topical-TXA, mean (range)	69 (52–85)	5′9″ (5′4″–6′5″)	217 (140–277)	30.4 (22–40.8)

For these patients, TXA was placed in the wound before closure and the hemovac drain was clamped for 30 minutes post operatively [11].

Allogeneic blood transfusion is the event for determining possible cost savings of TXA usage, therefore a standard measure is needed to determine when to administer a transfusion; a hemoglobin below 8 g/dL was set as the transfusion trigger for all patients and no variations were noted [11].

Several elements contribute to facility cost: cost of packed red blood cells per unit, cost associated with tranexamic acid per dose, cost of pre-hospitalization lab work as well as lab work required when a transfusion is ordered, and finally equipment utilization costs. Assistance from the hospital billing and purchasing departments allowed us to assign specific values to each element.

The man-hour cost was determined by working directly with hospital administration, nursing services and laboratory services. The pathway for a unit of packed red blood cells (PBRCs), from donor to TKA patient recipient, was evaluated. Provider, nursing, and blood bank protocols were reviewed to identify the minimum man-hour components of each element on the transfusion pathway. The elements were analyzed for three different outcomes: (1) the time needed to transfuse one unit of PRBCs, (2) the time required to transfuse additional units of PRBCs, and (3) the time associated with management of a transfusion reaction (Table 3).

Statistical analyses of costs were not performed. Our goal was not to determine if there was a statistically significant reduction but to determine if there was a cost reduction that would have practical significance

Results

The cost of packed red blood cells (PRBC) was $1130/U, each additional unit of PRBC was $291/U, and the cost of a transfusion reaction during the first unit of transfused blood cost $1197/reaction. The cost associated with TXA per dose at our institution was $39.14, one dose being used intra-operatively for topical application. For the two-dose regimen that was needed for intravenous application during this study, the cost was $78.28.

In the no-TXA group, there were 120 blood transfusions (6.5% of 1839 TKA) at a facility cost of $84.90/TKA ($156,137 total). This is compared to 1 transfusions in the IV-TXA group (0.3% of 330 TKA) with a facility cost of $82.59/TKA ($27,254 total) and is compared to 0 transfusions in the topical-TXA group (0% of 130 THA) with a facility cost of $39.14/TKA ($5,088 total) (Table 4). Thus, the IV-TXA group experienced a 95.38% reduction in blood transfusions while the topical-TXA group experienced a 100% reduction in blood transfusions when compared to the no-TXA group.

Analysis of the ratio of money spent on blood transfusion when TXA is used versus when it is not used revealed that when topical-TXA is utilized, there is a 53.90% reduction in cost to the institution associated with blood transfusion and drug delivery, and when IV-TXA is used, the savings is 2.72% when compared to blood transfusion in patients that do not receive TXA (Table 4).

Analysis of man-hour time utilized reveals that it takes at least 95 minutes (1.58 man-hours) to transfuse the first unit of PRBC. When additional units are ordered, another 40 minutes per unit is added to the initial 95 minutes. So a patient receiving 2 U of PRBC will require 135 minutes (2.25 man-hours), while a person receiving 4 U would require 215 minutes (3.58 man-hours). If a patient had a blood transfusion reaction, the additional nursing, administrative and blood bank procedures would require 205 minutes (3.42 man-hours), this was assuming that the transfusion reaction was noted during the first unit of transfused blood (Table 3).

In the no-TXA group, transfusions cost 0.13 man-hours/TKA (236.6 man-hours total) while the man-hours cost for IV-TXA was 0.007 man-hours/TKA (2.25 man-hours total) and the man-hours cost for topical-TXA group was zero man-hours/TKA (zero man-hours total).

The ratio of man-hours spent on blood transfusions when TXA is used versus when it is not used revealed that when topical-TXA is utilized, there is a 100% reduction in man-hours associated with blood transfusion, and when IV-TXA is used, there is an 94.62% reduction in man-hours when compared to patients who did not receive TXA (Table 4).

Table 2
Demographic Information for Female Patients ($n = 952$) (reprinted from Wind et al [11]).

	Age	Height	Weight (lb)	BMI
No-TXA, mean (range)	65 (31–91)	5′4″ (4′6″–6′2″)	202 (101–455)	34.4 (19.4–68)
IV-TXA, mean (range)	67 (42–91)	5′3″ (4′9″–5′9″)	188 (113–335)	31.9 (18.9–47.6)
Topical-TXA, mean (range)	72 (52–91)	5′4″ (4′7″–5′9″)	192 (133–274)	31.7 (22–46.4)

Discussion

Tranexamic acid treatment in total joint arthroplasty continues to evolve and demonstrates benefits to the patients undergoing these procedures and to the institutions using TXA. To our knowledge, this is the first paper to examine both the facility and the man-hour cost savings associated with TXA usage in TKA at a major joint replacement center. We found that TXA usage was associated with a reduction in facility costs (range: 53.90% topical-TXA to 2.72% IV-TXA) and a reduction in man-hour costs (range: 100% topical-TXA to 94.62% IV-TXA).

There are several weaknesses in our study. First, this is a retrospective study using data from the previous analysis of Wind et al that showed the effectiveness of TXA in reducing transfusions in our total knee population [11]. A prospective analysis would be a better method to track patient cost in real-time and would require a tracking system or program in place. Second, the review takes place at a single institution, and thus it may be difficult to extrapolate results across different systems and networks. Third, by allocating patients to the topical-TXA group based on medical risk factors, there is the potential for selection bias. Fourth, the lack of blood transfusions and the size of the population in the topical-TXA group clearly create a bias in our cost-analysis; thus, the cost–impact of topical-TXA should continue to be investigated. Fifth, we are unable to create a direct comparison of IV-TXA and topical-TXA due to the discrepancy in population sizes and incidence of blood transfusions. Sixth, outcomes, including complications and adverse events, were not reviewed as part of this analysis, and could affect price estimates significantly. Seventh, the man-hour cost analysis was based on what is perceived as minimum times it takes to accomplish tasks during blood transfusion. These times relating to health care workers represent the most accurate pathway we could identify to perform this review. Electronic Medical Records (EMR) may allow this pathway to be more accurately tracked in a prospective manner and give more precise results in the future.

Several authors have attempted to quantify indirect costs either in the general or orthopedic literature as it relates to blood transfusion. Ralley et al determined that before TXA, their per patient transfusion cost was $105.98 for TKA and THA patients, while after it was