Cost Analysis of Blood Transfusion and Tranexamic acid in Primary Total Knee Arthroplasty

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Purpose: *To determine transfusion rates and trends of allogenic blood transfusion in total knee arthroplasty patients and to analyze the cost of blood transfusions in TKA.*
Methods: *This study was a non-randomized retrospective study that included 342 osteoarthritis knees which underwent unilateral primary TKA from June, 2012 through June, 2014. The patients were categorized into 2 groups; group 1 were treated with tranexamic acid and group 2 received no treatment with tranexamic acid. All surgeries were performed in the Department of Orthopedics, Police General Hospital. The data of blood transfusion was collected from blood bank by software "BloodTrans" and the cost of blood transfusions were collected from the Pharmaceutical and Financial Department, Police General Hospital.*
Results: *342 total knee arthroplasty patients were included. The male:female ratio was 80:262. The average age was 68.74 (50-84) years. The average weight was 67.0 (58-90) kilograms. The average height was 163 (160-172) cm. The average BMI was 25.21(22.2-28.5) kg/m^2, the number of knees (right:left) were 216:126. The average level of preoperative Hct in group 1 was 36.40 % (30-44.5) and in group 2 was 38.7 % (30-43.5). The average level of postoperative Hct in group 1 was 31.4 % (26-40.5) and group 2 was 30.1 % (23-38.5). The overall number of patients who received blood transfusions was 164 (48%): in the tranexamic group 54 patients (36%) and 110 patients (58%) in the non-tranexamic acid group. The total number of blood units transfused was 233 units, and the overall average number of units received per patient was 0.68 units: in group 1 the average was 0.47 units and 0.85 units in group 2. The total cost of blood transfusions was 174,300 baht. The average cost of per blood transfusion was 530 baht per TKA: in the tranexamic group 463 baht (12% lower than average costs) and 584 baht (10% higher than average costs) in the non-tranexamic acid group.*
Conclusions: *The average number of units of blood transfused was lower than standard blood transfusions. But, the transfusion rate was higher than the standard treatment. The tranexamic group had lower transfusion rates and costs of blood transfusions compared to the non-tranexamic acid group. The use of tranexamic acid continues to rise and shows positive results. The indication of blood transfusions need to be evaluated with the appropriate criteria.*

Keywords*: Cost Analysis, Blood Transfusion, Tranexamic acid, Total knee arthroplasty*

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Introduction

Blood management involves the evaluation and optimization of the circulating blood volume prior to surgery. As we all know, the number of total knee arthroplasty (TKA) is going to increase in the future. However, the limitation of blood product is in the opposite direction of annual numbers of knee joint replacements. Even though the transfusion is simple, the risks of blood transfusions have led to the establishment of blood conservation programs in orthopedic surgery that have become more desirable[1,2]. The transfusion rate was historically 50% with the development in all technical aspects in total knee arthroplasty. However, nowadays, the transfusion rate is between 8% and 13%. Allogenic blood transfusion is of concern because of its cost, its potentials for disease reactions, its lack of religious tolerance and acceptance, its immunomodulation with the increased susceptibility for post-operative infection, its increased length of stay, its perception of illness, and its interference with PT/ambulation[3]. In conventional TKA, the average blood loss is between 600-1200 cc. Tranexamic acid use in bilateral TKA was associated with a significant reduction in perioperative serum hemoglobin drop, and a reduced need for allogeneic blood transfusion from 50% to 11% of patients. No autologous blood donation or drains were used and there were no venous thromboembolic events reported[13]. The concept of modern knee replacement with minimally invasive surgery (minimidvastus, subvastus) will preserve blood loss and decrease blood transfusions. Although tranexamic acid is used for the prevention of bleeding in TKA, a

cost analysis still needs to be investigated. The role of tranexamic acid in TKA has been confirmed in several studies, so cost-utility analysis should be studied prior to proposing it as a general recommendation.

Materials and Methods

Institutional Review Board approval was obtained from our institution for a retrospective chart review. This study was a non-randomized retrospective study that included 342 osteoarthritis knees which underwent unilateral primary TKA from June, 2012 through June, 2014. The patients were categorized into 2 groups; group 1 treated with tranexamic acid and group 2 received no treatment with tranexamic acid. All surgeries were performed in the Department of Orthopedics, Police General Hospital. The data of blood transfusions was collected from the blood bank by ”BloodTrans” software and the costs of blood transfusions were collected from the Pharmaceutical and Financial Department, Police General Hospital. The cost of cross matching, which was done for all patients, was 150 baht in each case and 750 baht for each bag of blood transfusion.

This was a cost analysis study considering the total costs of the treatment from the retrospective data in Police General Hospital from June, 2012 - June, 2014. The total cost of the treatment consisted of the direct medical costs including group matching, and the cost of blood transfusion. No indirect or disability costs were included for this analysis. The average cost per person and per knee (Baht) were analyzed. Statistical analysis and demographic data are shown as the mean.

Results

342 total knee arthroplasty patients were included. The male:female ratio was 80:264. The average age was 68.7 (50-84) years. The average weight was 67.0 (58-106) kg. The average height was 163 (160-172) cm. The average BMI was 25.2 (22.2-28.5) kg/m^2. The number of knees (right:left) included was 216:126. Baseline patient characteristics are summarized in Table 1. The total number of patients that received blood transfusions was 164 patients (48%): 54 patients (36%) in the tranexamic group and 110 patients (58%) in the non-tranexamic acid group. Comparing the average percentage of patients receiving blood transfusions, the tranexamic group had a lower percentage of about 31.43 percent compared to the non-tranexamic group of which about 21.2 percent received transfusions. The number of blood transfusions was 233 units, the total number of patients who received blood transfusion was 0.68 units: in the tranexamic group 0.47 units, and in the non-tranexamic acid group was 0.85 units.

Table 1 Baseline characteristics of patients

Characteristic	TXA	Non-TXA	Total
Number of patients (Male:Female)	52(50:102)	190(65:125)	342(80:264)
Mean (range) age (years)	66(50-82)	68(55-84)	68(50-84)
Mean (range) bodyweight (kg)	65.0(60-90)	67.5(58-85)	67.0(58-90)
Mean height (cm)	161(160-168)	162(161-172)	163(160-172)
Number of knees (Right:Left)	152(100:52)	190(116:74)	342(216:126)

Table 2 Prevalence of blood transfusion in TKR

Group	TXA	Non-TXA	Total
No. of patients	152	190	342
Mean Preop. Hct	36.4 (30.0-44.5)	38.7(30.0-43.5)	
Mean Postop.Hct	31.4(26.0-40.5)	30.1(23.0-38..5)	
No blood transfusion	98	80	178
Blood transfusion	54	110	164
Blood transfusion (%)	36	58	48
No. of unit transfusion	71	162	233
Average pt. No transfused	0.64	0.42	0.52
Average unit of transfusion	0.47	0.85	0.68

The total cost of blood transfusions was 174,300 baht. The average cost of a blood transfusion was 530 baht per TKA: in the tranexamic group 463 baht (12% lower than the average cost) and in the non-tranexamic acid group 584 baht (10% higher than the average cost)**.** *The total saving cost of tranexamic acid was about 22%*.

Table 3 Average costs of blood transfusions

Average	TXA	Non-TXA	Total (Baht)
Cost of cross matching	22,800	28,500	51,300
Cost of blood transfusion	40,500	82,500	123,000
Blood expense in TKA	63,300	111,000	174,300
Cost TXA	7,080	-	7,080
Total blood expense	70,380	111,000	181,380
Average cost of transfusion	463	584	530

Discussion

As we all know, the number of TKAs is going to increase in the future. However, the availability of blood is decreasing compared to the annual numbers of knee joint replacements in ageing societies.. Even though the transfusion is simple, the risks of blood transfusion have been established. The risks associated with blood transfusion include the potential for blood-borne infection, allergic reaction, and transfusion reactions. Furthermore, red blood cell (RBC) transfusions add significant cost to the healthcare system which will likely increase as demand continues to grow. Programs of blood conservation in orthopedic surgery have become more desirable.

The transfusion rate was historically 50% with the developments in all technical aspects in total knee arthroplasty. However, nowadays, the transfusion rate is between 8% and 13%. The average volume of blood transfused is 2.2 units. The concept of modern knee replacement with minimally invasive surgery (minimidvastus, subvastus) preserves blood loss and decreases blood transfusion. In our study, the average number of units of blood transfused is lower than standard blood transfusions. But the blood transfusion rate is higher than the standard treatment. The total number of patients who received blood transfusions was 164 (48%): 54 patients (36%) in the tranexamic group and 110 patients (58%) in the non-tranexamic acid group. Tranexamic Acid (TXA), a plasminogen-activator inhibitor, has been employed to reduce perioperative blood loss and prevent the need for post-operative transfusion. The reasons for lower numbers of units of blood transfused are improvements to and better understanding of the surgical techniques, and non-pharmacologic and pharmacologic agents, such as tranexamic acid. Blood Management has to be focused on pre-operatively, which includes medical

anemia evaluations and optimizations, and intra-operatively which includes modifications to anesthesia and surgical techniques, such as soft tissue techniques including exposure that should be quadriceps preservation, and handling soft tissue with MIS (minimally invasive surgery). Technique is recommended, tissue hemostasis during and after releasing the tourniquet electrocautery, especially the lateral inferior genicular artery at the posterolateral corner and the lateral superior genicular artery in lateral release or perforating branch in the subvastus approach. The bone techniques are precise bone cuts and the medullary canal technique. The medullary canal technique can be non-reaming by using an extra medullary guide and navigator or the conventional technique that generally is used with a bone plug, and post-operative which include blood salvage, standardization of hemoglobin, fluid management.

Health care costs are of concern. Tranexamic acid has been shown to be cost effective with reduced blood loss and transfusions, as well as its low cost compared to other anti-fibrinolytics. Chimento et al. compared the cost savings of TXA compared to a placebo group and reported higher pharmacy costs with use of TXA, but the savings from decreased blood transfusions and shorter hospital stays more than offset these higher pharmacy costs. Despite the significant literature support for the use of TXA in TKA, many common medical conditions, including renal insufficiency, history of previous DVT, and cardiac and cerebrovascular disease may contraindicate the use of intravenous tranexamic acid at the time of surgery. In our study, the total cost of blood transfusions was 174,300 baht. The average cost of a blood transfusion was 530 baht per TKA, 463 baht in the tranexamic group (12% lower than the average cost) and 584 baht in the non-tranexamic acid group (10% higher than the average cost). The overall cost saving is 22 percent. The tranexamic group had lower transfusion rates and costs of blood transfusion. Because of the increasing incidence of TKA in the future, there are rising concerns regarding the supply, cost, and excessive or inappropriate use of blood transfusions, to save medical costs.

Conclusions

The average number of units of blood transfused is lower in TKA patients than standard blood transfusions, but the transfusion rate is higher than the standard treatment. The tranexamic group had lower transfusion rates and costs of blood transfusions compared to the non-tranexamic acid group. The use of tranexamic acid continues to rise and shows positive results. The the administration of a blood transfusion needs to be evaluated using the appropriate criteria. This study compared the cost of blood transfusions and evaluated the cost analysis of tranexamic acid. The limitation of this study is that it is retrospective. The study suggests that further investigation and improvement of new surgical techniques and proven technologies, are required for improving the effectiveness of blood management.

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การวิเคราะห์ความคุ้มค่าของการให้เลือดและการใช้ Tranexamic acid ในการผ่าตัดข้อเข่าเทียม

ธนา ธุระเจน, พบ, ชัชวาลย์ วิเศษศิริพงษ์,พบ

วัตถุประสงค์: *เพื่อวิเคราะห์อัตราการให้เลือดหลังการผ่าตัดข้อเข่าเทียมและวิเคราะห์ถึงความคุ้มค่าของการให้เลือดในการผ่าตัดข้อเข่าเทียม*

วิธีการศึกษา: *การศึกษานี้เป็นการศึกษาย้อนหลังในผู้ป่วยจำนวน 342 ราย ที่ได้รับการผ่าตัดข้อเข่าเทียมข้างเดียวในโรงพยาบาลตำรวจ ระหว่างเดือนมิถุนายน 2555 ถึง เดือนมิถุนายน 2557 โดยแบ่งผู้ป่วยออกเป็นสองกลุ่ม กลุ่มแรกได้รับยา tranexamic acid ส่วนในกลุ่มที่สอง ผู้ป่วยไม่ได้รับยา tranexamic acid โดยผู้ป่วยทั้งสองกลุ่มได้เข้ารับการดูแลรักษา ในภาควิชาออร์โธปิดิกส์ โรงพยาบาลตำรวจ ข้อมูลในการให้เลือดได้รับการเก็บโดยโปรแกรมของธนาคารเลือด "BloodTrans" และค่าใช้จ่ายจากการให้เลือดเก็บข้อมูลจากห้องยาผู้ป่วยในและแผนกการเงินของโรงพยาบาลตำรวจ*

ผลการศึกษา: *ผู้ป่วยจำนวน 342 ราย ที่ได้รับการผ่าตัดข้อเข่าเทียม เป็นผู้ป่วยเพศชาย 80 ราย เพศหญิง 262 ราย อายุเฉลี่ย 68.7 (50-84) ปี น้ำหนักตัวเฉลี่ย 67.0 (58-90) กิโลกรัม ส่วนสูงเฉลี่ย 163.0 (160-172) เซนติเมตร ดัชนีมวลกาย 25.2 (22.2-28.5) กิโลกรัมต่อตารางเมตร จำนวนเข่าขวา 216 ราย เข่าซ้าย 126 ราย ความเข้มข้นของเลือดก่อนการผ่าตัดเฉลี่ยในกลุ่มที่หนึ่งร้อยละ 36.4 (30.0-44.5) กลุ่มที่สองร้อยละ 30.1 (30.0-43.5) ค่าความเข้มข้นหลังการผ่าตัดในผู้ป่วยกลุ่มที่หนึ่งร้อยละ 31.4 (26.0-40.5) และกลุ่มที่สองร้อยละ 30.1 (23.0-38.5) ผู้ป่วยจำนวน 164 รายได้รับเลือดหลังการผ่าตัดข้อเข่าเทียมคิดเป็นร้อยละ 48 ของผู้ป่วยทั้งหมด โดยในผู้ป่วยจำนวนนี้เป็นผู้ป่วยในกลุ่มที่หนึ่งจำนวน 54 ราย (ร้อยละ 36) และผู้ป่วยกลุ่มที่สองจำนวน 110 ราย (ร้อยละ 58) และจำนวนเลือดที่ใช้ไปทั้งหมดเป็น 233 ยูนิต ค่าเฉลี่ยของจำนวนเลือดที่ใช้ต่อผู้ป่วยทั้งหมดเท่ากับ 0.68 ยูนิตต่อคน โดยในผู้ป่วยกลุ่มที่หนึ่งค่าเฉลี่ยเท่ากับ 0.48 ยูนิตต่อคนและในกลุ่มที่สองเท่ากับ 0.85 ยูนิตต่อคน ราคาของเลือดที่ให้ผู้ป่วยทั้งหมดคือ 174,300 บาท โดยมีค่าใช้จ่ายเฉลี่ยของการให้เลือดต่อการผ่าตัดข้อเข่าเทียมทั้งหมดคือ 530 บาท ค่าใช้จ่ายเฉลี่ยของการให้เลือดต่อกลุ่มผู้ป่วยกลุ่มที่หนึ่งคือ 463 บาท (น้อยกว่าค่าใช้จ่ายเฉลี่ยรวมร้อยละ 12) และต่อผู้ป่วยกลุ่มที่สองคือ 584 บาท (สูงกว่าค่าเฉลี่ยรวมร้อยละ 10) โดยสามารถลดค่าใช้จ่ายของการให้เลือดโดยการใช้ยา tranexamic acid ไปได้ประมาณร้อยละ 22*

สรุป: *จำนวนปริมาณเลือดที่ให้ผู้ป่วยในการศึกษาน้อยกว่าการให้เลือดในมาตรฐานทั่วไปของการผ่าตัดข้อเข่าเทียม แต่อัตราการให้เลือดกับผู้ป่วยสูงกว่ามาตรฐานทั่วไป การใช้ยา tranexamic acid ทำให้อัตราการให้เลือดลดลงและค่าใช้จ่ายจากการให้เลือดลดลงด้วยเมื่อเทียบกับกลุ่มที่ไม่ได้ให้ยา ซึ่งจากการศึกษาพบว่าการใช้ยา tranexamic acid มีผลดีต่อการรักษาโดยข้อบ่งชี้ในการให้เลือดแก่ผู้ป่วยหลังการผ่าตัดข้อเข่าเสื่อมควรจะต้องมีการพิจารณาในการศึกษาต่อไป*