Original Article

Effectiveness of a Blood Transfusion Guideline in Major Orthopaedic Surgery

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Background: Major orthopedic surgery often requires allogeneic blood transfusion that involves a risk for infection and other complications. The decision to transfuse is typically at the surgeon's discretion.

Objective: To evaluate the effect of a blood transfusion guideline on allogeneic transfusion rates, volumes and outcomes in patients with major orthopedic surgery.

Materials and Methods: Data were collected retrospectively in 115 patients before implementing a guideline (pre-guideline group), and prospectively in 115 patients to whom a guideline defining criteria for red cell transfusion was applied (guideline group). The guideline for packed red cell transfusion was a hematocrit <25% or a hemoglobin of <8 g/dL. These thresholds were disregarded if the clinical situation warranted it. Clinical data and post-operative outcomes were recorded and compared.

Results: The two groups were not significantly different with respect to age, sex, BMI, ASA classification, pre-operative cHb/Hct level, operative time and intraoperative blood loss. In the pre-guideline group, 45 (39.1%) patients received transfusion compared to 22 (19.1%) in the guideline group (p = 0.001). Patients in the pre-guideline group received more transfusion (0.68±1.02 units) than the guideline group (0.24±0.68 units). Mean difference of blood transfusion between two groups, 0.48 units (95% CI 0.23 to 0.73), was statistically significant (p<0.001). There were no significant differences in outcome.

Conclusion: A transfusion guideline using hematocrit and hemoglobin thresholds reduced the frequency and volume of allogeneic blood transfusions without increasing postoperative complications in patients with major orthopedic surgery.

Keywords: Blood transfusion, Red blood cells, Transfusion guidelines, Orthopaedic surgery, Side effects, Risks, Complications

J Med Assoc Thai 2019;102(Suppl.9): 1-4
Website: http://www.jmatonline.com

Major orthopedic surgery often requires allogeneic blood transfusion. In the US, 19.0% of total hip arthroplasty (THA)[1], 4.5% of total knee arthroplasty (TKA) and 6.1% of spine surgery patients receive a transfusion. Kato et al reported that 5.2% of spine surgery, patients receive up to 840 ml allogeneic red cells[2], which is equivalent to 3 units of packed red cells (PRC). Blood transfusion is costly and adds risk of morbidity and mortality[3]. While transfusion transmitted infections have become less common, there is increasing concern about PRC transfusion and its influence on mortality and morbidity such as sepsis, pneumonia, deep venous thrombosis, and prolonged hospital stay[4-7].

There are few published data regarding blood transfusions in Thailand and the decision to tranfuse is generally left to the discretion of the surgeon. Narissirikul et al[8] implemented a guideline for preoperative cross matching in orthopedic surgical patients at Siriraj Hospital, resulting in a significant reduction of unnecessary cross matching. The authors aimed to explore the effect of a guideline using hematocrit and hemoglobin thresholds on the rate and volumes of blood transfusions and patient outcomes.

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Materials and Methods

The study was approved by the ethic committee of Siriraj Hospital, Bangkok (COA No. Si 030/2017). All patients provided written informed consent. Data were retrospectively collected from the electronic medical records of 115 patients (January 2015 to June 2015; Pre-guideline Group). Data from a second group of 115 patients (April 2018 to June 2018) were prospectively collected after implementation of the transfusion guideline (Guideline Group).

Patients who underwent the following operations were included; arthroplasty (hemi- or total hip arthroplasty, and total knee arthroplasty), open reduction and internal fixation of major bones (pelvis, femur, and humerus), spine surgery (decompression, correction of deformity, and stabilization), and tumor surgery (pelvis, femur, and humerus). Patients who had multiple trauma, massive

How to cite this article: Uedilokkunthorn K, Bormann BV, Thanapipatsiri S. Effectiveness of a Blood Transfusion Guideline in Major Orthopaedic Surgery. J Med Assoc Thai 2019;102(Suppl.9): 1-4.

transfusion, sepsis, and relevant cardiac history within 30 days were excluded.

The blood transfusion guideline was designed by the investigators based on published data regarding safe restrictive red cell therapy[4,9], and communicated to the Orthopedic and Anesthesia departments before implementation.

Packed red cell transfusion could be administered if the hematocrit (Hct) was <25% or hemoglobin (cHb) was <8 mg/dl[9-13]. Physicians could deviate from the protocol in case of myocardial ischemia, such as ST-elevation, arrhythmia, chest pain, heart failure, unexplainable tachycardia, shock or acute hemorrhage. Blood transfusion had to be performed unit by unit until the target value was achieved. Hematocrit and/or hemoglobin concentration were checked before and during operation, and post-operation on days 1, 2, 4, and before discharge.

Demographic data and clinical characteristics were described using mean and standard deviation or median and range for continuous variables, and frequency and percentage for categorical variables. The Shapiro-Wilks test was performed to test for normality. The Independent t-test or Mann-Whitney U test were used when appropriate to compare means including age, BMI, operative time, intraoperative blood loss and blood transfusion. The Chi-square test for homogeneity was employed to determine if proportions between the two groups had the same distribution. Multivariable analysis with regression for mean was used to compare the volume of blood transfusion while controlling for gender, anesthesia methods, and operative procedure. Statistical significance was set at $p<0.05$. All statistical analysis was performed using STATA version 14 (StataCorp, College Station, Texas, USA).

Results

Two hundred thirty patients (2x115) were included. The two groups did not differ significantly with respect to age, sex, BMI, ASA classification, pre-operative cHb level, pre-operative Hct level, operative time and intraoperative blood loss (Table 1). The pre-guideline group more often had regional anesthesia for hip and knee-arthroplasty (54 [47%] vs. 23 [20%]; $p<0.001$). The guideline group received general anesthesia more frequently (77 [67%] vs. 43 [37.4%]; $p<0.001$). There was significantly more spine surgery in the guideline group (62 [53.9%] vs. 27 [23.5%]; $p<0.001$).

The postoperative packed red cell (PRC) transfusion rate was significantly higher in the pre-guideline group (0.68±1.02 PRC units, 218.13±331.34 ml) compared to the guideline group (0.24±0.68 PRC units, 82.73±231.24 ml) ($p<0.001$). After controlling for gender, anesthesia method and operative procedure, there was a statistically significant reduction in blood transfusion of 0.48 PRC units (95% CI 0.23 to 0.73) or 147.82 ml (95% CI 66.41 to 229.24) per person in the guideline group.

There were no significant differences regarding perioperative morbidity, complications or length of hospital stay (LOS) (Table 2). Hematocrit level before discharge was 32.1±4.25 in the post-guideline group, but these data were not available for the pre-guideline group.

Discussion

The transfusion guideline reduced the proportion of patients that received a blood transfusion from 39.1% to 19.1% ($p = 0.001$) without increasing morbidity or mortality.

Table 1. Patients characteristics and perioperative data

Parameters	Pre-guideline group (n = 115)	Guideline group (n = 115)	*p*-value
Age (yrs), mean ± SD	61.4±18.7	62.3±15.1	0.774
Male, n (%)	51 (44.3)	39 (31.3)	0.057
BMI (kg/m^2), mean ± SD	23.73±4.3	25.02±5.3	0.078
ASA classification, n (%)			
I	13 (11.3)	10 (8.7)	0.669
II	75 (65.2)	74 (64.3)	
III	27 (23.5)	30 (26.1)	
IV	0 (0)	1 (0.9)	
Anesthesia method, n (%)			
General anesthesia	43 (37.4)	77 (67)	<0.001
Regional anesthesia	54 (47)	23 (20)	
Both	18 (15.7)	15 (13)	
Operative procedure, n (%)			
Arthroplasty	50 (43.5)	32 (27.8)	<0.001
Trauma surgery	20 (17.4)	14 (12.2)	
Spine surgery	27 (23.5)	62 (53.9)	
Tumor surgery	17 (14.8)	4 (3.5)	
Operative time (min), mean ± SD	164.4±106.7	159.2±49.5	0.571
Intraoperative blood loss (ml), mean ± SD	608.3±814	455.3±448.2	0.566
Pre-operative cHb level (mg/dl), mean ± SD	12.6±1.9	12.5±1.6	0.537
Pre-operative Hct level (%), mean ± SD	38.3±4.8	38.1±4.6	0.734

Table 2. Allogeneic blood transfusion and perioperative outcomes

Variables	Pre-guideline group (n = 115)	Guideline group (n = 115)	Mean diff* (95% CI)	*p*-value
Transfused PRC (unit), mean ± SD	0.68±1.02	0.24±0.68	0.48 (0.23 to 0.73)	<0.001
Transfused PRC (ml), mean ± SD	218.13±31.34	82.73±31.24	147.82 (66.41 to 229.24)	<0.001
Length of stay (day), mean ± SD	12.02±18.69	9.42±10.58	2.6 (1.34 to 6.54)	0.239
Hct before discharge (%), mean ± SD	NA	32.1±4.25	NA	NA
Number of transfused patients, n (%)	45 (39.1%)	22 (19.1%)	33 (20%), (7.66% to 31.57%)	0.001
Complications				
Cardiac complications	1	1		0.999
Infections	12	11		
Venous thromboembolism	0	0		
Death	1	1		

* controlling for gender, anesthesia method used and operative procedure

Allogeneic blood transfusion has associated risks even when the volume is small. A multicenter study of Ferraris et al[5] in non-cardiac surgical patients compared about 15,000 patients receiving a single unit of homologous red cells to nearly 900,000 non-transfused patients. Patients that did not receive a transfusion had significantly better outcomes in terms of mortality, wound healing, pneumonia and sepsis. The pathophysiology of the negative effect of red cell transfusion on postoperative outcome is not yet known. Transfusions may induce a shift of the immunologic environment, as summarized by Long et al[14] and Youssef et al[15]. Consequently, every unit transfused must be carefully considered and fully indicated.

To reduce the need for allogeneic transfusion, skilled surgeons must work meticulously to control bleeding. Auto-transfusion, hemodilution, autologous pre-deposit and intra-operative re-transfusion of salvaged blood are valuable options to conserve blood in planned surgery[16,17]. Finally, the most simple and immediately applicable method is to set a restrictive threshold for red cell transfusion via formal guideline.

Hospitals around the world have implemented transfusion guidelines with great success[10-12,18]. Carson et al reviewed controlled trials in which patients were randomized to an intervention group with restrictive red cell transfusion thresholds or to a control group. They concluded that the implementation of a guideline with a cHb threshold of between 7.0 to 8.5 g/dl significantly reduced the consumption of allogeneic blood without increasing perioperative morbidity or mortality, even in cardiac risk groups[19]. Munoz et al[20] agreed that a restrictive transfusion trigger for red cells (≤8 g/dl cHb) does not put patients at increased risk. Our results also demonstrate that a restrictive transfusion strategy reduces allogeneic blood consumption and does not compromise surgical outcomes, while reducing transfusion related complications, including transfusion related immunosuppression (TRIM)[21].

In addition, reducing the rate of allogeneic blood transfusion also reduces costs. In our study, packed red cell transfusions were reduced from 78 to 28 units overall, resulting in a cost saving of 71,000 Thai Baht (THB).

Conclusion

Implementation of a blood transfusion guideline (hematocrit level <25% or hemoglobin concentration <8 mg/dl), significantly reduced allogeneic blood transfusions, and did not increase postoperative complications in patients who underwent major orthopedic surgery.

What is already known on this topic?

Restrictive blood transfusion guidelines can be safely used for patients undergoing total joint arthroplasty and spine surgery, without increasing morbidity or mortality.

What this study adds?

The guideline can be implemented and used risk-free in a patient population with major orthopedic surgery. It is the first guideline of its kind in Thailand.

Acknowledgements

The authors gratefully acknowledge the support of the staff of the Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University. The authors thank Miss Krabkaew Soparat and Miss Wachirapan Narktang from the Clinical Research Unit, Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University for their assistance with statistical analysis.

Potential conflicts of interest

The authors declare no conflict of interest.

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