

Prevalence and Associated Factors of Blood Transfusion in Spinal Surgery at Maharat Nakhonratchasima Hospital: A Retrospective Study

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Background: Spine surgery is a high rate of blood transfusion. This is costly and may have many adverse effects. Previous studies showed multiple factors associated with blood transfusion but in our institute, there is no exact data. Our study is designed to identify prevalence and associated factors of blood transfusion.

Methods: A retrospective study was designed to identify all patients undergone spine surgery between 1st February 2019 to 31st January 2020. Demographic data including amount of blood component given, age, gender, ASA physical status, BMI, underlying disease, preoperative hemoglobin, diagnosis and the details of surgery, operative time and intraoperative blood loss were collected. Primary outcome was a prevalence of blood transfusion and secondary outcome was the associated factors of this transfusion.

Results: Five hundred and sixty-five patients were included. One hundred and three patients required

packed red cell (PRC) transfusion and sixteen patients required fresh frozen plasma (FFP). Mean PRC and FFP transfusion are 447.63 and 442.81 ml. One patient needs 10 units of platelet transfusion. Factors associated with blood transfusion were pulmonary disease (p-value=0.01, OR=3.60), low preoperative hemoglobin (10-13 g/dl; p-value <0.001, OR=4.51, < 10 g/dl; p-value=0.01, OR=8.06), > 3 levels of surgical segments (p-value=0.001, OR=3.75), posterior approach (p-value=0.01, OR=5.13) and operative time >120 minutes (p-value<0.001, OR=19.26).

Conclusions: Prevalence of blood transfusion is 22% that is considered high and the need for transfusion is associated with multiple factors. Health care providers should be aware and well-prepared these cases vigilantly in order to optimize patient management.

Keywords: associated factors, blood transfusion, prevalence, spine surgery

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Background

Orthopedic surgery especially spine surgery is a major surgery and consider having an elevated risk of perioperative blood loss with significant associated with more blood component transfusion requirements. This transfusion is costly and may have many adverse effects including hemolytic reaction, transmission of infectious disease, transfusion related acute lung injury (TRALI),

transfusion associated graft-versus-host diseases.^{1,2}

Many anesthetic and surgical techniques also patient characteristic have been cited as possible factor influencing blood loss that needs transfusions. Previous studies had shown many factors that increased blood transfusion requirements such as Berenholtz et al.³ mentioned that age >66 years, female gender, preoperative hemoglobin concentration, diabetes with

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chronic complications, metastatic tumor emergency room admission and greater hospital volume increased risk of receiving any allogeneic transfusion. Bulteret al.⁴ said that significant risk of requiring a transfusion >2 units of RBC included deformity surgery, tumor surgery, trauma surgery and multilevel surgery (>3 levels). According to Nuttalla GA. Et al,⁵ the significant determinants for an increased amount of autologous red blood cell units transfused on the day of surgery were increased autologous red blood cells available, low preoperative hemoglobin concentration, and increased number of posterior levels surgically fused.

Maharat Nakhonratchasima Hospital is the tertiary referral center for all spinal injuries and complicated diseases of the spine warranting surgical intervention in the lower northeastern region of Thailand. Nowadays, we have to face the problem of wasting resources for preparing too many blood components. We decided to do this study that aim to show prevalence of blood transfusion and identify risk factor associated with perioperative transfusion. The purpose of this study was first, to allow the early recognition of patients at greatest risk, and second, to improve existing transfusion practices allowing safer, cost effective and more appropriate blood product allocation.

Materials and Methods

Data collections

We included all patients undergoing spine surgery at Maharat Nakhonratchasima Hospital between 1st February 2019 to 31st January 2020 by retrospective study (n = 565). After approved from the Hospital Institution Review Board (MNRH IRB number is 039/2020), anesthetic records and electronic outpatient data from the hospital databases were used to identify all patient characteristics, surgical and anesthetic techniques.

We developed a data collecting form to record the amount of blood component given, age, gender, ASA physical status, BMI, underlying disease such as

hypertension, diabetes, neurovascular disease, pulmonary disease and cardiovascular disease, preoperative hemoglobin concentration, diagnosis of surgery, neural decompression, use of instrument, number of surgical segments, approach, level of surgery (cervical VS thoracolumbar), fusion techniques, operative time and intraoperative blood loss.

Patients with a history of hypertension, pulmonary disease, neurovascular disease, cardiovascular disease, and diabetes were considered as having a major comorbidity. Cardiovascular diseases were defined by a history of myocardial infarction, congestive heart failure, coronary artery disease, arrhythmia, mitral valve prolapse, ventricular septum defect, or atrial fibrillation. Pulmonary diseases were defined by a history of chronic obstructive pulmonary disease, asthma, pulmonary tuberculosis, or pneumonia. Neurovascular diseases were defined by cerebrovascular accident, numbness, muscle weakness or spinal cord injury. Hypertension was defined by a history of medication treatment, and diabetes was defined in the same way.

Statistical analysis

Demographic data is expressed as number count and percentage of patients are expressed for categorical variables that fisher's exact test was used for identify difference between groups.

Sample size was calculated by the preoperative hemoglobin concentration which is the strong predictor for deciding to give a blood transfusion according to previous studies.^{3,5} In a pilot study of our institute, the incidence of blood transfusion was 0.2. In blood transfusion group, there was 10 per cents of patient had preoperative hemoglobin concentration less than 10 g/dl and 2 per cents of patients in non-blood transfusion groups had preoperative hemoglobin concentration less than 10 g/dl. Program STATA version 15.0 was used for calculating sample size so estimated sample size for a two-sample proportions test was 552 (alpha error was 0.05, power was 0.8).

Primary outcome was reported by prevalence of blood and blood component transfusion. Secondary outcome is the associated factors of perioperative blood transfusion were assessed using univariate logistic regression followed by multivariate logistic regression to calculated independent risk factors and odd ratio by using program STATA version 15.0. All variables with statistical significance (p -value < 0.05) in the univariate analyses were included in these logistic regressions. In the final models, a p -value of 0.05 was used to indicate statistical significant.

Results

There are 565 patients who underwent spine surgery. Twenty two percent of the patients required blood transfusion (RBCs, FFP or platelet) (Table 1). There are 103 patients received packed red cell transfusion, mean packed red cell transfusion is 447.63 milliliters (standard deviation is 261.67), approximately 1.7 units. 16 patients received packed red cell and fresh frozen plasma transfusion, mean fresh frozen plasma transfusion is 442.81 milliliters (standard deviation is 189.10), approximately 2.1 units and only one patient needs 10 units of platelet transfusion, of cause, he also received packed red cell and fresh frozen plasma transfusion too.

Patient characteristics, comorbid diseases, details of surgery and intraoperative blood loss of patients with and without blood transfusion are shown in table 2. In blood transfused group, more patients are female

gender (65% compared to 48% in non-blood transfusion group; p -value = 0.003), ASA physical status III-V (p -value = 0.001), had hypertension (p -value = 0.019), pulmonary disease (p -value = 0.002), low preoperative hemoglobin (p -value < 0.001) compared with another group. About the details of surgery, blood transfusion group had more decompression technique (p -value = 0.001), instrument used (p -value = < 0.001), more than 3 levels of surgical segments (p -value < 0.001), posterior approach (p -value = 0.001), thoracolumbar level (p -value = 0.022), posterolateral and interbody fusion (p -value < 0.001) and operative time more than 120 minutes (p -value < 0.001) compared with patients that did not require any blood transfusion. In blood transfusion groups, mean intraoperative blood loss was 1042.72 milliliters and 184.70 milliliters in non-blood transfusion groups.

Factors associated with blood transfusion in the multivariate logistic analysis were pulmonary disease (p -value = 0.01, odd ratio 3.60, 95% CI 1.35-9.59), low preoperative hemoglobin (10-13g/dl; p -value < 0.001 , odd ratio 4.51, 95% CI 2.28 - 8.92, < 10 g/dl; p -value = 0.01, odd ratio 8.06, 95% CI 1.43 - 45.40), more than 3 levels of surgical segments (p -value = 0.001, odd ratio 3.75, 95% CI 1.72 - 8.18), posterior approach (p -value = 0.01, odd ratio 5.13, 95% CI 1.34-19.52) and operative time more than 120 minutes (p -value < 0.001 , odd ratio 19.26, 95% CI 6.17-60.13). Other factors were not statistically significant (p -value > 0.05) (Table 3).

Table 1 Prevalence of blood transfusion in spine surgery. Total = 103 patients (22.29%)

Blood components	Number of patients	Mean - ml (SD)	Number of blood unit (SD)
Packed red cell	103	447.631 (261.679)	1.728 (0.992)
Fresh frozen plasma	16*	442.812 (189.102)	2.125 (0.806)
Platelet	1*	-	-

* No patients received only FFP nor platelet without PRC transfusion

Table 2 Characteristics of spine surgery patients (n = 565)

Patients Characteristic	Blood transfusion (103)	Non-Blood transfusion (462)	P-value
Age (years)			
- < 65	76 (73.79)	365 (79.00)	0.292
- > 65	27 (26.21)	97 (21.00)	
Gender			
- Male	36 (34.95)	236 (51.08)	0.003
- Female	67 (65.05)	226 (48.92)	
ASA physical status			
- I - II	38 (36.89)	255 (55.19)	0.001
- III - V	65 (63.11)	207 (44.81)	
BMI (kg/m ²)			
- < 25	69 (66.99)	285 (61.69)	0.637
- 25 - 30	24 (23.30)	127 (27.49)	
- > 30	10 (9.71)	50 (10.82)	
Underling disease			
- Hypertension	51 (50.00)	172 (37.23)	0.019
- Diabetes	22 (22.00)	69 (15.07)	0.100
- Neurovascular disease	43 (42.16)	158 (34.27)	0.139
- Pulmonary disease	15 (14.56)	25 (5.41)	0.002
- Cardiovascular disease	3 (2.91)	9 (1.95)	0.466
Preoperative hemoglobin (g/dl)			
- > 13	18 (17.48)	213 (46.10)	<0.001
- 10 - 13	75 (72.82)	231 (50.00)	
- < 10	10 (9.71)	18 (3.90)	
Diagnosis			
- degenerative	61 (59.22)	281 (60.82)	0.431
- infection	9 (8.74)	28 (6.06)	
- trauma	21 (20.39)	117 (25.32)	
- tumor	8 (7.77)	25 (5.41)	
- deformities	4 (3.88)	11 (2.38)	
Revision surgery	10 (9.71)	45 (9.74)	1.000
Decompression	97 (94.17)	379 (82.03)	0.001
Instrument	98 (95.15)	296 (64.07)	<0.001
Number of surgical segments			
- 1 - 3 levels	72 (69.90)	426 (92.21)	<0.001
- > 3 levels	31 (30.10)	36 (7.79)	
Approach			
- Anterior	7 (6.80)	95 (20.56)	0.001
- Posterior	96 (93.20)	367 (79.44)	
Level of surgery			
- Cervical	16 (15.53)	123 (26.62)	0.022
- Thoracolumbar	87 (84.47)	339 (73.38)	
Fusion			
- None	6 (5.83)	171 (37.01)	<0.001
- Posterolateral	80 (77.67)	253 (54.76)	
- Interbody	17 (16.50)	38 (8.23)	
Operative time (minutes)			
- 0 - 120	5 (4.85)	250 (54.11)	<0.001
- > 120	98 (95.15)	212 (45.89)	
Intra-operative blood loss (ml)*	1042.72 +/- 859.4163	184.7072 +/- 256.650	<0.001

*showed mean (SD)

Table 3 The multivariate analysis for associated factors of any blood transfusion.

Associated Factors	Odd Ratio	95% Confident Interval	P-value
Age (years)			
- < 65	Ref		
- > 65	0.703	0.346 - 1.428	0.331
Gender- female	1.937	0.970 - 3.867	0.061
ASA physical status			
- I - II	Ref		
- III - V	1.782	0.906 - 3.503	0.094
BMI (kg/m ²)			
- < 25	Ref		
- 25 - 30	0.659	0.333 - 1.303	0.231
- > 30	1.017	0.363 - 2.845	0.974
Underling disease			
- Hypertension	0.859	0.424 - 1.736	0.672
- Diabetes	1.217	0.535 - 2.769	0.639
- Neurovascular disease	1.351	0.719 - 2.536	0.349
- Pulmonary disease	3.608	1.357 - 9.592	0.010
- Cardiovascular disease	1.060	0.120 - 9.332	0.958
Preoperative hemoglobin (g/dl)			
- > 13	Ref		
- 10 - 13	4.517	2.286 - 8.926	<0.001
- < 10	8.061	1.431- 45.407	0.018
Diagnosis			
- degenerative	Ref		
- infection	0.421	0.123 - 1.437	0.167
- trauma	0.903	0.388 - 2.104	0.815
- tumor	1.828	0.540 - 6.182	0.331
- deformities	0.246	0.046 - 1.314	0.101
Revision surgery	0.875	0.333 - 2.302	0.788
Decompression	1.596	0.412 - 6.170	0.498
Instrument	3.457	0.217 - 54.929	0.379
Number of surgical segments			
- 1 - 3 levels	Ref		
- > 3 levels	3.757	1.725- 8.183	0.001
Approach			
- Anterior	Ref		
- Posterior	5.131	1.348 - 19.528	0.016
Level of surgery			
- Cervical	Ref		
- Thoracolumbar	1.017	0.337 - 3.071	0.975
Fusion			
- None	Ref		
- Posterolateral	0.839	0.058 - 12.073	0.898
- Interbody	0.887	0.057 - 13.775	0.932
Operative time (minutes)			
- 0 - 120	Ref		
- > 120	19.269	6.174 - 60.131	<0.001

P-value < 0.05 is statistically significant

Discussion

This study was designed to ascertain prevalence and associated preoperative factors predicting intraoperative blood and blood component transfusion. All these patients were undergone spine surgery which is an intermediate risk surgery⁶ and complicated by significant intraoperative blood loss that need for blood transfusion. Prevalence of transfusion in our study (estimate 22%) is similar to that of other surgical procedures considered to carry a high risk for blood transfusion (i.e., cardiac surgery).⁷ About blood component transfusion, mean packed red cell transfusion is 447.63 milliliters (approximately 1.7 units), mean fresh frozen plasma transfusion is 442.81 milliliters (approximately 2.1 units and only one patient needs 10 units of platelet transfusion. There is no patient need fresh frozen plasma or platelet without packed red cell transfusion that means indication for blood component transfusion is to prevent dilution coagulopathy from massive blood loss.⁸ If focus on volume of blood and blood component given, seem like lower blood volume to define massive blood transfusion, this means that the physician who decided to give blood transfusion trends to use early blood component transfusion. And the only one patient who needs 10 units of platelet transfusion had massive blood loss (approximate 5,500 milliliters), he received 6 units of packed red cell (1650 milliliters) and 4 units of fresh frozen plasma (920 milliliters).

The associated factors of blood transfusion in spine surgery as determined by linear multiple regression analysis were pulmonary disease, low preoperative hemoglobin, multilevel of surgical segments (> 3 levels), posterior approach and operative time more than 120 minutes, which correlated with previous study.³⁻⁵

We found that patients with pulmonary disease are higher risk of blood transfusion, may be the reason is the physician trend to maintain higher hemoglobin concentration to improve oxygen delivery to tissue by blood transfusion. Associated with previous study, the current authors reported that a history of pulmonary disease was a significant indicator for red blood

cell transfusion in patients undergoing total hip arthroplasty.⁵

The preoperative hemoglobin concentration is an important factor of the number of red blood cells transfused, lower preoperative hemoglobin concentration, higher rate for receiving blood transfusion. These results are not surprising because red blood cell transfusions are administered to maintain oxygen delivery to the patients' tissues. Other surgical procedures have shown preoperative hemoglobin concentration to be a significant indicator for allogeneic red blood cell transfusion.^{5,9,10} Prior studies on the predictors of transfusion requirements in spine surgery have not included preoperative hemoglobin as a variable.^{11,12}

In the details of surgery, more level of surgical segment involvement (in our study is more than 3 levels), results more blood loss and blood transfusion needed. Operative time more than 120 minutes is explained as the same. Posterior approach technique may cause more blood loss because this technique, paraspinal muscles are the layer that was dissected through the vertebra and in our institute, anterior approach is mostly done in cervical spine segment surgery that is naturally minimal blood loss compared to thoracolumbar surgery.

Spine surgery is the operation associated with dramatic blood loss, so we have to well-prepare patients' status and intraoperative management. The results of our study will help to do that. Our study has large population and includes multi-type for spine surgery compared with previous studies so we can apply the results to larger groups of patients.

Limitation of our study is the methods of study (retrospective study) that might not receive complete data and more sample size is need for evaluating other associated factors. There is some confounding factor that we cannot avoid, that is no standard indication for blood transfusion, decision making depended on individual physicians. With our results, we should develop predictive score for blood transfusion and type of blood component, may be further study should do for extending external validity and for practical used.

In conclusion, this study is shown that spine surgery is a high rate of blood transfusion and there are many preoperative associated factors for blood transfusion that can be well prepared. Health care providers can use important information from our study to provide informed risk-benefit discussions with patients regarding blood component transfusion prior to surgery.

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