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Preoperative Predictors of Peri-operative Red Blood Cell Transfusion in Major Pediatric Surgical Procedures

Hasun Muhamad, MD*
Surasak Sangkhathat, MD*
Alan Geater, PhD**
Worapong Chawchoowej, MD*
Sakda Patrapinyokul, MD*

**Department of Surgery, and **Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Hadyai, Songkla 90110, Thailand.*

Abstract

Background: **Unnecessary pre-operative request of blood cross-matching causes unnecessary medical expenses. To reduce the "cross-matching" to "transfuse" ratio needs data regarding the actual use of blood in certain group of patients.**

Objective: **To determine the preoperative predictors of peri-operative red blood cell transfusion in major pediatric surgical procedure. The data will be valuable in establishing practice guideline for blood request in our service.**

Materials and Methods: **Medical records of pediatric patients aged 0-14 years who underwent elective major surgery in the pediatric surgical service, Songklanagarind hospital from May 1996 to June 2001 were reviewed regarding preoperative clinical and hematologic status, type of operation, blood request and blood transfusion. Univariate exploration for crude association was done, using Pearson Chi squared test. Multivariate analysis employed the logistic regression models and stepwise exclusion. Statistical significance was set at p-value less than 0.05.**

Results: **There were 366 patients (operations) included in the analysis. Blood were requested for 334 cases whereas 115 cases (34.4%) received transfusion. Univariate exploration showed possible associations (P<0.2) of red blood cell transfusion with associated pulmonary disease, associated renal disease, diagnosis, type of operation, ASA score, operative time and estimated blood loss. The multivariate analysis finally revealed preoperative hemoglobin level and type of operation as the only significant preoperative predictors for red blood cell transfusion (p<0.05).**

Conclusions: **Multivariate analysis of various factors associated in the red blood cell transfusion practice in a pediatric surgical service was done. Type of operation and pre-operative hemoglobin level were found to be the key transfusion predictors.**

Preoperative request for blood preparation in our pediatric surgical service currently has no practice guideline. Blood or blood product are requested on a routine basis for the operation that the attending physician feels to be a major one. The "cross-matching" to "transfusion" ratio (C:T) of red blood cell products in our ward in fiscal year 2001 was reported to be 3.2:1,[1] whereas the optimum C:T ratio recommended by the American Association of Blood Bank (1999) was 2:1.[2] Reduction of unnecessary requests has to be achieved without increasing the risk to patients. The objective of this study is to find pre-operative clinical factors that capable of determining the need or requirement of red blood cell transfusion in major pediatric surgical

procedures. Data from this study will help in establishing a practice guideline for blood request in the pediatric surgical service.

Materials and Methods

Patients and data

Clinical data of pediatric patients aged up to 14 years who underwent general anesthesia and elective major surgery in pediatric surgical service, Songklanagarind Hospital, from May 1996 to June 2001 were retrieved from our computerized records. Patients undergoing emergency surgery or minor surgery were not included. Data were gathered retrospectively regarding pre-operative clinical and hematologic status, type of operation, blood request and blood transfusion. The preoperative factors included the diagnosis, surgeons, type of operation, and American Society of Anesthesiologists (ASA) score. Operative types were categorized into tumor surgery, hepato-biliary tract, small bowel, stomach and duodenum, abdominal wall, colorectal surgery and miscellaneous. Neonatal procedures were classified as a distinct group. Estimated blood loss was converted to percentage of blood volume calculated according to body weight. In our pediatric surgical service, the senior surgical resident made the decision to request for blood cross-matching under the supervision of pediatric surgical staff. Intra-operative blood transfusion was managed by the attending anesthesiologists.

Data review was done under the permission of the Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University.

Analysis

Univariate exploration for crude association with

Table 1 Percentage red blood cell transfusion according to peri-operative variables.

Factors	No. (cases)	No. Transfusion (%)	P-value*
Sex Male	211	69 (32.7)	0.357
Female	155	47 (30.3)	
Co-morbid diseases;			
Cardiac disease	22	7 (31.8)	0.990
Pulmonary disease	12	0 (0.0)	0.016
Renal disease	9	5 (55.6)	0.119
Thalassemia	19	6 (31.6)	0.991
Types of operation;			< 0.0005
Tumor surgery	50	28 (56.0)	
Hepatobiliary, spleen	57	30 (52.6)	
Small bowel procedures	8	3 (37.5)	
Colorectal procedures	164	39 (23.2)	
Neonatal surgery	44	9 (20.5)	
Stomach and duodenum	32	5 (15.6)	
Miscellaneous (abdominal wall, thyroid, breast, KUB, laparoscopy)	11	2 (16.7)	
Operative time (minutes)			< 0.0005
0-60	56	3 (5.4)	
61-120	141	24 (17.0)	
121-180	70	24 (34.3)	
> 180	99	65 (65.7)	
Estimated blood loss (% blood volume)			< 0.0005
0-10	279	58 (20.2)	
11-20	62	37 (59.7)	
> 20	25	21 (84.0)	
Pre-operative Hemoglobin level (g/dl)			< 0.0005
< 11	142	70 (49.3)	
> 11	224	46 (20.5)	

** Pearson Chi squared test*

red blood cell transfusion was done for all variables using Pearson Chi-squared test. Variables having a P value < 0.2 were then included in multivariate logistic regression models, which were refined by stepwise exclusion guided by the change in log-likelihood of consecutive models. The P-value for significance in the likelihood ratio test was set at 0.05.

Results

There were 366 pediatric patients (211 males and 155 females) who underwent major surgery during the five-year period. Forty-two percent of the patients were less than one year old and 63 percent aged less than two years. Packed red blood cell cross-matching was requested in 334 cases (91.3%). Of these, 116 patients (34.7%) received transfusion. Only one of 32 cases in whom blood cross-matching had not been prepared needed transfusion.

Univariate exploration showed possible associations (P<0.2) with red blood cell transfusion of associated pulmonary disease, associated renal disease, diagnosis, type of operation, operative time and estimated blood loss (Table 1). These factors were selected for multivariate logistic regression modeling. Diagnosis and type of operation expressed almost the same information and thus were almost co-linear. Of these two factors, only type of operation was chosen to be analyzed. Stepwise exclusion revealed statistically significant independent associations with blood use of hemoglobin level, estimated blood loss and operative time.

However, since estimated blood loss and operative time were the variables not available pre-operatively, regression modeling was repeated excluding these two factors. Finally, type of operation and hemoglobin level were shown to be significant independent predictors of transfusion (Table 2). The probabilities of the need for a transfusion in our study population were then calculated for all combinations of these two factors, using the final logistic regression model (Table 3).

Discussion

The decision to transfuse red blood cells to a patient undergoing an operation mainly relates to the degree of intra-operative blood loss and the underlying physiologic status. However, blood use is likely to be predicted by certain pre-operative determinants. Accurate prediction not only leads to the safety of the patients, but also ensures appropriate utilization of limited resources.

Previous studies have reported the key influence of anemic status on peri-operative transfusion.[3,4] Hemoglobin level less than 10.0 g/dl is usually the trigger level for transfusion although this "cut-off" level lacks adequate scientific support.[5] In our study, seventy patients (40.9%) with hemoglobin level less than 11g/dl received blood transfusion. Multivariate analysis also suggested that hemoglobin level was one of the transfusion risks in our service.

Intra-operative blood loss and operative duration according to our analysis were other independent

Table 2 Final multivariate logistic regression model

Factors	Sub-type	Odds ratio	95% CI	p-Value*
Type of operation	Tumor surgery	1.00	-	< 0.05
	Hepatobiliary, spleen	0.46	0.19-1.09	
	Stomach, duodenum	0.14	0.04-0.44	
	Small bowel	0.46	0.09-2.44	
	Colorectal	0.27	0.14-0.54	
	Neonatal	0.23	0.09-0.60	
	Abdominal wall, thyroid, breast	0.08	0.01-0.78	
Pre-operative hemoglobin level (g/dl)	≥ 11.0	1.00	-	< 0.05
	10.0-10.9	2.04	1.07-3.88	
	9.0-9.9	3.94	1.82-8.53	
	< 9.0	5.83	2.56-13.25	

Likelihood ratio test

Table 3 Probability of transfusion according to type of operation & hemoglobin level.*

Operation	Hemoglobin (g/dl)	Probability
Abdominal wall, thyroid, breast	≥ 11.0	0.063
	10.0-10.9	0.121
	9.0-9.9	0.210
	<9.0	0.283
Hepatobiliary, spleen	≥ 11.0	0.270
	10.0-10.9	0.430
	9.0-9.9	0.593
	< 9.0	0.683
Stomach, duodenum	≥ 11.0	0.099
	10.0-10.9	0.184
	9.0-9.9	0.303
	< 9.0	0.391
Small bowel	≥ 11.0	0.272
	10.0-10.9	0.432
	9.0-9.9	0.595
	<9.0	0.685
Neonatal	≥ 11.0	0.157
	10.0-10.9	0.276
	9.0-9.9	0.423
	<9.0	0.526
Tumor	≥ 11.0	0.446
	10.0-10.9	0.621
	9.0-9.9	0.760
	<9.0	0.824
Colorectal	≥ 11.0	0.179
	10.0-10.9	0.308
	9.0-9.9	0.462
	< 9.0	0.560

**Calculated for the study population using the multivariate logistic model shown in Table 2.*

factors associated with red blood cell transfusion. However, neither factors could be used preoperatively to predict transfusion. None the less, in the absence of these two factors, type of operation became a significant predictor.

Predicted probabilities of transfusion in our study population ranged from less than 10 percent (for abdominal wall, thyroid, breast surgery and hemoglobin of 11.0 g/dl or abobe, to over 80 percent (for tumor surgery in moderately anemic patients). Among non-anemic patients, tumor surgery carried a 45 percent probability of requiring a transfusion requirement, except for colorectal surgery only had a 17 percent probability.

Various transfusion guidelines have been established to reduce unnecessary transfusion.[6,7] On the other hand, cross-matching guidelines are hardly found in the literature. Most of the blood bank charges incur in the cross-matching of blood and there is no refund if the blood is not used. Our most recent recorded data (fiscal year 2001) show a C:T ratio in our pediatric surgical ward of 3.2:1 with 317 surplus units.[1] Given a reduction in the ratio to 2:1, approximately 170 units of cross-matching of blood or approximately 102,000 Baht could be saved. Our results suggest the feasibility of estimating the probability of a requirement for transfusion using pre-operative determinants. A guideline could be developed based on the type of operation and pre-operative hemoglobin level.

Conclusion

This study retrospectively reviewed pre-operative predictors of red blood cell transfusion in major pediatric surgical procedures. Pre-operative hemoglobin level and type of operation were the two significant predictors of transfusion given in these patients.

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