ORIGINAL ARTICLE

Bali Journal of Anesthesiology (*BJOA*) 2019, Volume 3, Number 2: 93-97
E-ISSN: 2549-2276

Published by DiscoverSys

Estimation of surgical blood loss and transfusion requirements in orthopedic soft tissue tumor surgery

Aino Nindya Auerkari,* Aida Rosita Tantri, Anas Alatas

ABSTRACT

Background: Over half of soft tissue tumor surgeries require intraoperative packed red cell (PRC) transfusion. Several factors that can be identified in the preoperative period have been associated with surgical bleeding and transfusion in soft tissue tumor surgery. This study aimed to determine factors associated with surgical blood loss and intraoperative PRC transfusion.

Methods: A retrospective cohort was analyzed on 84 records of orthopedic soft tissue tumor surgery during 2014-2018. Data were analyzed by linear regression and multivariate analysis.

Results: Most commonly found malignant tumor in this study was rhabdomyosarcoma (20.2 %). Preop hemoglobin of 11.5 g/dL ($p<0.013$) and tumor size of 5 cm ($p<0.001$) are the two significant predictors for intraoperative transfusion.

Conclusion: tumor size and preoperative Hb value were predictors of the probability of requiring intraoperative PRC transfusion.

Keywords: Soft tissue tumor surgery, bleeding, PRC transfusion, preoperative hemoglobin level, tumor size.

Cite This Article: Auerkari, A.N., Tantri, A.R., Alatas, A. 2019. Estimation of surgical blood loss and transfusion requirements in orthopedic soft tissue tumor surgery. *Bali Journal of Anesthesiology* 3(2): 93-97. DOI:10.15562/bjoa.v3i2.156

Department of Anesthesiology and Intensive Care, Faculty of Medicine, University of Indonesia/Cipto Mangunkusumo Hospital

INTRODUCTION

Sarcomas are malignant tumors which are mostly of soft tissue origin. These tumors account for 20% of adolescent and young adult malignancy and 1% of adult malignancy in the world.[1,2] In general, its incidence is 2-3 cases of soft tissue tumors per 100,000 people.[1] Most of these tumors appear in the extremities and therefore are often presents in orthopedic patients.

One of the main first-line treatments for soft tissue tumors is surgery, and bleeding remains one of its most common complications. Bleeding in soft tissue tumor surgery varies widely from 10 ml to 20.000 ml.[3-6] Almost 60% of these surgeries require intraoperative packed red cell (PRC) transfusion.[7] Rapid blood loss during surgery may disturb patient hemodynamics, imposing them to hypoxia and ischemia, and increased risk for morbidity and mortality.[6,8,9]

On the other hand, ensuring blood availability requires complex management, and if blood product remains unused until it reaches its expiry date, it goes to waste. This waste accounted for a loss of US$ 400,000 in January-July 2017 in our hospital, where only 3,000 packs were used out of roughly 7,000 packs that were prepared for surgery.[10] Good planning may reduce bleeding, staff workload, blood product wasted due to miscalculation, and promote better patient safety.

Several factors have been associated with bleeding in soft tissue tumor surgery. Some of these factors can be identified in the preoperative period, such as the American Society of Anesthesiology (ASA) class, preoperative hemoglobin (Hb) level, tumor size, tumor location, and malignancy.[3-5] This study aimed to identify factors related to perioperative transfusion requirement.

METHODS

This is a retrospective cohort at Cipto Mangunkusumo Hospital that reviewed 110 medical records. Inclusion criteria were all adult patients (above 18 years-old) underwent orthopedic-oncology soft tissue tumor surgery between January 2014 and June 2018. We excluded patients who underwent closed biopsies such as needle and core biopsy, patients with coagulation pathologies (such as hemophilia and Von Willebrand disease), and patients with postoperative hemoglobin values of <10 g/dl. Incomplete data were dropped out. The study protocol was approved by the institutional review board of the hospital.

The sample size was calculated using a standard sample size formula where 200 ml is considered as minimal significant volume difference for transfusion. From the formula used we obtained a minimum sample size for multivariate analysis of five variables were 78 subjects. Out of 110 medical records reviewed, 84 passed the study criteria for analysis.

We collected ASA status, preoperative Hb values, tumor location, tumor size, and tumor malignancy, the amount of bleeding, PRC transfused in the intraoperative period, age, gender, body mass index (BMI), coagulation status, type of surgery, type of

*Correspondence to:
Aino Nindya Auerkari, Department of Anesthesiology and Intensive Care, Faculty of Medicine, University of Indonesia/Cipto Mangunkusumo Hospital, Jl. Diponegoro 71, Jakarta 10430, Indonesia
aino.auerkari@gmail.com

anesthesia, duration of surgery, the origin of tumor and history of chemotherapy and radiotherapy were noted.

Data were analyzed in Statistical Package for the Social Sciences (SPSS) software version 23.00 (IBM Corp, Armonk, NY, USA). To assess the association between the factors to bleeding volume, we used a bivariate analysis followed by multivariate analysis. A linear regression model was made to quantify the association. A p value of <0.05 was considered significant.

Table 1 Baseline characteristic

Characteristics observed	N (%)
Gender	
Male	45 (53.6)
Female	39 (46.4)
BMI (kg/m^2), mean±SD	22.16±4.42
Anesthetic technique	
General anesthesia	35 (41.7)
Regional anesthesia	33 (39.3)
Combined general and regional	16 (19)
Surgery duration (minutes), median (min-max)	225 (30-750)
ASA physical status	
1 and 2	62 (73.8)
3 and 4	22 (26.2)
Preoperative hemoglobin value	
≤11.5 g/dl	32 (38.1)
>11.5 g/dl	52 (61.9)
Tumor location	
Pelvis and thigh	30 (35.7)
Others	54 (64.3)
Tumor size	
≤5 cm	27 (32.1)
>5 cm	57 (67.9)
Tumor malignancy	
Malignant	48 (57.1)
Benign	36 (42.9)
Surgery	
Wide excision	27 (32.1)
Marginal excision	13 (15.5)
Excision and reconstruction	13 (15.5)
Amputation	13 (15.5)
Disarticulation	8 (9.5)
Mass reduction	5 (6.0)
Synovectomy	4 (4.8)
Debridement	1 (1.2)
Total blood loss (ml), median (min-max)	300 (5-4000)
PRC transfusion (ml), median (min-max)	0 (0-1670)

BMI: body mass index; SD: standard deviation; ASA: American Society of Anesthesiologists; PRC: packed red cells

RESULT

Table 1 shows the characteristics of the subjects involved. All subjects had normal thrombocyte, prothrombin time (PT), and activated partial thromboplastin time (APTT) levels. While one subject received preoperative chemotherapy, none underwent preoperative radiotherapy. Only two surgeons with similar level of experience and expertise were in charge of all surgeries recorded. All of the cases were a tumor of primary origin except for one case.

Most commonly found malignant tumor in this study was rhabdomyosarcoma (20.2%), and most commonly found benign tumor was neurofibroma (9.5%). Most bleeding recorded was 4,000 ml in neurofibroma excision surgery. Most subjects in this study did not receive intraoperative PRC transfusion.

Association between variables observed with the amount of bleeding was initially analyzed in bivariate manner (Table 2) and followed by multivariate method (Table 3). From this analysis, we found that tumor size and preoperative hemoglobin value were significant predictors of intraoperative PRC transfusion.

We assessed the probability of intraoperative PRC transfusion given patient's tumor size and preoperative hemoglobin value (Table 4). To determine the quality of calibration of the equation, we used the Hosmer and Lemeshow test which implies proper calibration (p=0.823). Figure 1 showed a receiving operator characteristics (ROC) graph of

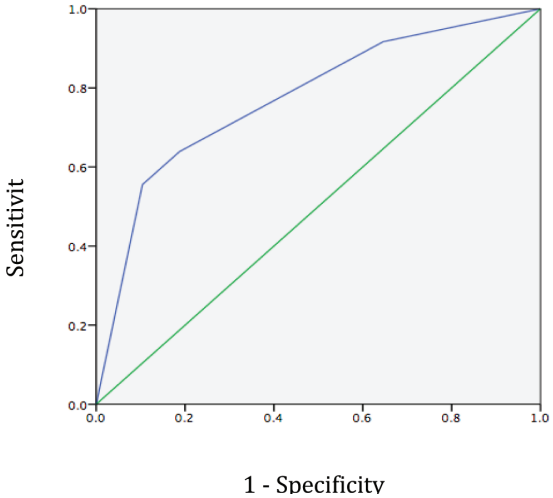

Figure 1 Receiving operator characteristic (ROC) curve of the probability of packed red cells (PRC) transfusion in soft tissue tumor surgery

Table 2 Bivariate analysis of factors associated with surgical bleeding

Variable	Bleeding volume (ml)	p-value[a]
ASA		
ASA 1-2	200 (5-4000)	0.093
ASA 3-4	400 (20-2700)	
Preoperative hemoglobin		
≤ 11.5 g/dl	500 (5-2200)	0.013
> 11.5 g/dl	200 (5-4000)	
Tumor size		
< 5 cm	100 (5-2000)	<0.001
≥ 5 cm	500 (25-4000)	
Tumor location		
Others	200 (5-4000)	<0.001
Pelvis and thigh	525 (50-2700)	
Tumor malignancy		
Benign	175 (5-4000)	0.039
Malignant	450 (20-2700)	

[a]Mann-Whitney test; ASA: American Society of Anesthesiologists;
Bleeding volume is presented in median (min-max)

Table 3 Association between ASA score, preoperative hemoglobin value, tumor size, location, and malignancy to the probability of receiving PRC transfusion

	PRC transfusion intraoperative			
Variable	No	Yes	OR (CI 95%)	p-value[a]
Tumor location				
Others	34 (63.0)	20 (37.0)	1.945 (0.786-4.804)	0.148
Pelvis and thigh	14 (46.7)	16 (53.3)		
Tumor size				
≤ 5 cm	21 (77.8)	6 (22.2)	3.889 (1.367-11.065)	0.009
>5 cm	27 (47.4)	30 (52.6)		
Tumor malignancy				
Benign	23 (63.9)	13 (36.1)	1.628 (0.672-3.944)	0.279
Malignant	25(52.1)	23 (47.9)		
Preoperative Hb				
>11.5 g/dl	39 (75.0)	13 (25.0)	7.667 (2.838-20.713)	<0.001
<11.5 g/dl	9 (28.1)	23 (71.9)		
ASA score				
1 and 2	39 (62.9)	23 (37.1)	2.449 (0.907-6.617)	0.073
3 and 4	9 (40.9)	13 (59.1)		

[a]Chi-square test; PRC: packed red cells; OR: odds ratio; CI: confidence interval; Hb: hemoglobin;
ASA: American Society of Anesthesiologists

Table 4 Probability of receiving PRC transfusion

		Preoperative Hb value (g/dl)	
		< 11.5	>11.5
Tumor size (cm)	> 5	78%	33%
	≤ 5	50%	12%

PRC: packed red cells; Hb: hemoglobin

the probability of transfusion in soft tissue tumor surgery. The area under the curve (AUC) of the graph was 77%, which was reasonably good to predict transfusion. The specificity of this model was 81.25% with a sensitivity of 63.88%.

DISCUSSION

The total blood loss in this study ranged from 5-4,000 ml. This range is relatively narrower compared to other studies by Kawai (0-26,050 ml) and Tang (100-16,300 ml), most likely due to a smaller number of samples.[3,5] None of the patient have coagulopathy, which was consistent with a review from Cata *et al.* which showed that it is scarce for elective oncological surgery to have coagulopathy.[11] This is most likely due to preoperative corrective measures.

In our study, preoperative Hb value had a significant association with the number of PRC transfusions (p=0.001). Patients with preoperative Hb of ≤11.5 g/dl had a chance of getting PRC transfusion 7.6 times higher compared to those with preoperative Hb of >11.5 g/dl (p <0.001). These results are similar to previous studies, i.e., patients who have experienced anemia in the preoperative period have a higher need for transfusion.[4] This finding is also consistent with studies in other tumor types that found that preoperative Hb is a risk factor for perioperative transfusion.[12]

Several reasons may explain why preoperative Hb value is important. First, patients with lower Hb value has lower red blood cells reserve, and cannot tolerate much blood loss. The patient may have earlier signs of hypoxia, and this would make physician quick to give a transfusion. Second, preoperative anemia may suggest that the tumor has more vascularization and is prone to more bleeding with surgical manipulation. Anemia is also associated with other effects of chemotherapy agents, such as thrombocytopenia and endothelial dysfunction.[11,12] Therefore, some studies suggest Hb be optimised preoperatively through blood transfusion or erythropoiesis recombinant.[6,13]

Tumor size had a significant association with the amount of bleeding (p <0.001), and is an independent predictor of bleeding in linear regression. Patients with tumor size of >5 cm also had a chance of receiving PRC transfusions 3.8 times higher (CI 95% 1.367-11.065) compared to those with a tumor size of ≤ 5 cm (p=0.009). This finding was consistent with the results of Thompson et al. who found that tumor size was a strong predictor of perioperative bleeding.[4] Tang[5,14] also found that tumor volume was an important independent risk factor associated with a 3-fold increase in bleeding risk. This was found despite most tumors in his

study were benign tumors.[5] Large tumors involve a larger resection area and are also more likely to attach or invade the surrounding organs, which causes difficult surgical resection and increases the risk of bleeding. The extent of surgery in large-sized tumors was more complex and was thought increased the difficulty and risk of bleeding.[5] This finding is consistent with studies on other types of tumor.[15,16]

By plotting the association between factors and intraoperative PRC transfusion in logistic regression, we can determine the probability described in table 4. From this logistic regression analysis, it was found that preoperative Hb and tumor size had a role in determining the probability of giving intraoperative PRC transfusion. From the equation, it is known that if the patient has Hb ≤11.5 g/dl and the tumor size is more than 5 cm, then the probability of getting a PRC transfusion is 78%. Therefore, it is better for the clinician to prepare blood in the preoperative period. On the other hand, if the Hb was >11.5 g/dl and tumor size is ≤5 cm, then the probability of getting a transfusion was only 12%. With a low likelihood, preparing a preoperative PRC is more likely to cause waste.

This result is consistent with other studies, which found that patients who were more anemic in the preoperative period and had a larger tumor size, tended to need more transfusions. ASA status, tumor malignancy, and tumor location did not affect the likelihood of receiving transfusion in the multivariate analysis of their study and were likely to be confounders in bivariate analysis.[3-5]

Probability assessment for PRC transfusion requirement has not been done before. If possible, future studies should explore more on the predicted number of PRC units needed in surgery as this would be more meaningful in clinical practice to help prepare for surgery. More subjects are required to get better estimation of the amount of PRC needed.

Some limitations do exist in this study. The amount of bleeding collected in the medical record is an estimation. The subjects in our study did not have coagulopathy, so this data cannot be inferred for patients at high risk of coagulopathy. This study also does not control other factors that can theoretically relate to the amount of bleeding and the need for transfusion of PRC. Factors such as operator expertise, anesthesia techniques, diathermy use, and use of tourniquets are some of the factors mentioned that can affect the amount of bleeding and the need for transfusion of PRC.[3,5,6,11,17]

To examine the effects of these factors, further research is needed with prospective designs and larger sample size. It would also be interesting to note the effect of identifiable preoperative factors on surgical blood loss in other types of tumors. Transfusion given in the study was influenced by multiple factors such as Hb value at the time, patient's comorbidity and clinical conditions, as well as the availability of blood products.

CONCLUSION

Tumor size of >5 cm is a determinant factor of intraoperative bleeding. Tumor size and preoperative Hb value can be used as a predictor for the administration of intraoperative PRC transfusion.

ACKNOWLEDGMENT

The authors report no conflict of interests.

REFERENCES

1. Burningham Z, Hashibe M, Spector L, Schiffman JD. The epidemiology of sarcoma. *Clin Sarcoma Res*. 2012;2(1):14. DOI:10.1186/2045-3329-2-14
2. Poon E, Quek R. Soft tissue sarcoma in Asia. *Chin Clin Oncol*. 2018;7(4):46. DOI: 10.21037/cco.2018.08.06.
3. Kawai A, Kadota H, Yamaguchi U, Morimoto Y, Ozaki T, Beppu Y. Blood loss and transfusion associated with musculoskeletal tumor surgery. *J Surg Oncol*. 2005;92:52-8. DOI: 10.1002/jso.20375
4. Thompson PA, May D, Choong PF, Tacey M, Liew D, Cole-Sinclair MF. Predicting blood loss and transfusion requirement in patients undergoing surgery for musculoskeletal tumors. *Transfusion*. 2014; 54(6):1469-77. DOI: 10.1111/trf.12532.
5. Tang X, Guo W, Yang R, Tang S, Ji T. Evaluation of blood loss during limb salvage surgery for pelvic tumours. *Int Orthop*. 2008;33(3):751-6. DOI:10.1007/s00264-008-0695-8.
6. Eyesan S, Idowu O, Obalum D, Nnodu O, Abdulkareem F. Perioperative haemorrhage and transfusion in musculoskeletal tumour surgery. *Niger J Orthop Trauma*. 2008:7(2):63-5. DOI: 10.4314/njotra.v7i2.29326.
7. Verlicchi F, Desalvo F, Zanotti G, Morotti L, Tomasini I. Red cell transfusion in orthopaedic surgery: a benchmark study performed combining data from different data sources. *Blood Transfus*. 2011;9(4):383-7. DOI:10.2450/2011.0095-10.
8. Mitchell MD, Betesh JS, Ahn J, Hume EL, Mehta S, Umscheid CA. Transfusion thresholds for major orthopedic surgery: a systematic review and meta-analysis. *J Arthroplasty*. 2017;32(12):3815–21. DOI: 10.1016/j.arth.2017.06.054.
9. American Society of Anesthesiology. Practice Guidelines for perioperative blood management: an updated report by the American Society of Anesthesiologists Task Force on Perioperative Blood Management. *Anesthesiology*. 2015;122(2):241-75. DOI: 10.1097/ALN.0000000000000463.
10. Kapuangan C, Utariani A, Hanindit, E. Factors associated with the need for intraoperative packed red cells transfusion in pediatric liver transplant patients. *Bali Journal of Anesthesiology*. 2019;3(1):69-73. DOI:10.15562/bjoa.v3i1.143
11. Cata JP, Gottumukkala V. Blood loss and massive transfusion in patients undergoing major oncological surgery: what do we know? *ISRN Anesthesiology*. 2012;2012:918938. DOI: 10.5402/2012/918938.
12. Sherbourne KR, Earl HM, Whitehead L, Jefferies SJ, Burnet NG. Blood transfusion requirements for patients with sarcomas undergoing combined radio- and chemotherapy. *Sarcoma*. 2005;9(3-4):119-25. DOI:10.1080/13577140500180005.

13. Bedair H, Yang J, Dwyer MK, McCarthy JC. Preoperative erythropoietin alpha reduces postoperative transfusions in THA and TKA but may not be cost-effective. *Clin Orthop Relat Res*. 2014;473(2):590-6. DOI:10.1007/s11999-014-3819-z.
14. Tang X, Guo W, Yang R, Tang S, Ji T. Risk factors for blood loss during sacral tumor resection. *Clin Orthop Relat Res*. 2008;467(6):1599–604. DOI:10.1007/s11999-008-0483-1.
15. Liu H, Li B, Yu X, Huang Y. Preoperative risk factors for massive blood loss in adrenalectomy for pheochromocytoma. *Oncotarget*. 2017;8(45):79964-70. DOI:10.18632/oncotarget.20396.
16. Hsu SY, Huang YH. Characterization and prognostic implications of significant blood loss during intracranial meningioma surgery. *Transl Cancer Res*. 2016;5(6):797-804. DOI: 10.21037/tcr.2016.11.72.
17. Karmaniolou I, Makris A, Lamprou K, Staikou C. Perioperative management of patients with bone and soft tissue tumors: a narrative review. *Acta Anaesth Belg*. 2017;68:1-12.