Surgical Neurology International

SNI: Spine, a supplement to Surgical Neurology International

OPEN ACCESS

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Editor: Nancy E. Epstein, MD Winthrop University Hospital, Mineola, NY, USA

Primary elective spine arthrodesis: Audit of institutional cross matched to transfused (C/T) ratio to develop blood product ordering guidelines

Muhammad Mehboob Alam, Zain A. Sobani[1], Muhammad Shahzad Shamim, Khabir Ahmad[2], Fouzia Minai[3]

Departments of Neurosurgery, [1]Biological and Biomedical Sciences, [2]Ophthalmology, [3]Anesthesiology, Aga Khan University, Karachi, Pakistan

E-mail: Mehboob Alam - muhammad.alam@aku.edu; Zain Sobani - zsobani@gmail.com; *Muhammad Shahzad Shamim - shahzad.shamim@aku.edu; Khabir Ahmed - khabir.ahmad@aku.edu; Fouzia Minai - fauzia.minai@aku.edu
*Corresponding author

Received: 19 June 13 Accepted: 19 August 13 Published: 29 October 13

This article may be cited as:
Alam MM, Sobani ZA, Shamim MS, Ahmad K, Minai F. Primary elective spine arthrodesis: Audit of institutional cross matched to transfused (C/T) ratio to develop blood product ordering guidelines. Surg Neurol Int 2013;4:S368-72.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2013/4/6/368/120778

Abstract

Background: Currently, there are no uniform guidelines regarding the appropriate amount of blood products ordered prior to spine surgery. Here, we audited our own institution's practices along with preoperative variables that contributed to perioperative transfusion requirements for elective spinal arthrodesis.

Methods: This study utilized a single institution retrospective chart review of patients undergoing elective spinal fusion over a 2 year period. The cross matched to transfused (C/T) ratio was utilized to compare different patient groups. Sub-group multivariate analysis enabled us to identify possible predictors of transfusion for this patient population.

Results: Eighty-five patients were included in the study. Of the 292 units of packed red blood cells ordered preoperatively, only 66 were transfused (C/T ratio 4.4:1). Those undergoing arthrodesis for degenerative disease (6.9:1) or cervical spine arthrodesis (23:1) had the highest C/T ratios. Univariate analysis revealed several factors contributing to a relatively high probability of perioperative transfusions, while multivariate analysis showed that the indication for surgery was the only factor independently associated with the requirement for transfusion.

Conclusion: We found an unacceptably high C/T ratio at our institution. Based on the results of our univariate analysis, we recommend that two units packed cells to be arranged for patients with preoperative hemoglobin levels <9 g/dl, trauma, and Adult Idiopathic Scoliosis (AIS) cases, or where more than two levels were being decompressed and/or arthrodesed. For the remainder of the cases, a group and hold policy should be sufficient.

Key Words: Arthrodesis, cross matched/transfusion ratio, elective spine arthrodesis, elective surgery, prediction of transfusion requirements

Access this article online

Website: www.surgicalneurologyint.com

DOI: 10.4103/2152-7806.120778

Quick Response Code:

INTRODUCTION

With innovations regarding the safety and efficacy of spinal arthrodesis, the numbers of complex reconstructive fusion procedures are increasing with technical advances in spine surgery, the numbers of complex spinal

reconstructive procedures are increasing.[2] Although historically such procedures were associated with major blood loss, further advances in surgical techniques, methods of hemostasis, and improved anesthetic and perioperative management strategies have significantly reduced the perioperative transfusion requirements.[5]

Presently, the blood loss and transfusion requirements for patients undergoing spinal procedures are being overestimated.[4] This often leads to large amounts of blood products being ordered but remain unutilized. A recent study reported over a 70% incidence of predonated units arranged for patients undergoing elective spinal surgery remaining unutilized and being discarded.[8]

Currently there are no specific evidence-based guidelines for the appropriate amount of blood products to be ordered prior to specific spine procedures. Rather, excessive amounts of blood products are ordered due to outdated preoperative institutional or anecdotal surgeon-specific guidelines. This results in an unnecessary increased workload for the blood bank, increased cost to the patient, and waste.[1]

To address this issue, we introduced a new institutional cross matched to transfused (C/T) protocol at a single institution over a 2-year period. This involved auditing the C/T practices of our institution and comparing them with the literature; by analyzing the various preoperative factors that contributed to blood transfusions for patients undergoing spinal surgery/fusions, we developed a Maximum Surgical Blood Order Schedule.

MATERIALS AND METHODS

A retrospective chart review of all adults undergoing elective spine arthrodesis with or without decompression at our institution was performed over a 2-year period (June 1, 2009 to June 30, 2011). Patients undergoing noninstrumented fusion, multiple surgeries, operative revisions, and tumor surgery were excluded. Surgical data included; the preoperative status of patients, indications for surgery, operative approaches, the surgical levels, the number of levels decompressed and arthrodesed, the implants used, the duration of surgery, and intraoperative complications [Table 1].

Clinical data

A total of 95 patients underwent elective spine arthrodesis at our institution during the review period. Of these, 85 patients met the inclusion criteria; 52.94% (n = 45) of them were male and 47.05% (n = 40) were female. The mean age of study subjects was 38.8 ± 18.5 years. Of the 85 patients, 11% (n = 10) were hypertensive, 6% (n = 5) were diabetic, and 5% (n = 4) had ischemic heart disease.

The primary indication for surgery in 47.05% (n = 40) of the patients was degenerative spine disease, followed by trauma 20% (n = 17), adult idiopathic scoliosis (AIS) 15.29% (n = 13), and infections including Pott's disease 5.88% (n = 5). A total of 52.9% (n = 45) of the patients had spinal arthrodesis via a posterior approach, while the remaining patients underwent the procedure via anterior approach 31.76% (n = 27), circumferential approach 8.23% (n = 7), and lateral approach 7.05% (n = 6).

Table 1: Basic clinical parameters of the study participants

	Male (n=45)		Female (n=40)		Total	
	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation
Age in years	42.27	15.43	35.03	21.00	38.86	18.51
Preop hemoglobin	13.53	1.89	12.19	1.35	12.90	1.78
Postop hemoglobin	11.89	1.91	10.10	1.72	11.05	2.02
Duration of surgery (minutes)	297.56	148.68	315.88	162.56	306.18	154.70
Number of levels fused	3.50	2.84	4.77	3.92	4.10	3.43
Number of levels decompressed	1.80	1.21	1.20	1.02	1.51	1.16
Estimated blood loss (ml)	831.22	702.81	600.38	378.38	722.59	581.93

Analysis of cross matched vs. transfused ratio

The blood bank data were retrieved for 85 procedures, and were analyzed regarding the total number of packed cell units ordered for each patient vs. the total units transfused (C/T Ratio).[1,7] Patients were then sub-divided according to age, gender, presence or absence of comorbidities, preoperative hemoglobin, indication and approach for surgery, specific region of the spine being operated, and number of levels decompressed and/or arthrodesed. C/T ratios were subsequently calculated for each group [Tables 2 and 3]. Statistical analyses utilized the Statistical Package for Social Sciences Version 19.0 for Windows (International Business Machines, Armonk, NY). Continuous variables were expressed as mean (SD), whereas categorical variables were expressed as frequency counts and percentages.

Introduction of new cross matched protocols

Next, we introduced institutional protocols based on the C/T ratios found for different spinal surgical procedures. First determining the association between outcome (bloods transfusion) and the other study variables, we utilized univariate analysis (e.g. Chi-squared tests, or Fisher's Exact test) where appropriate. Variables with a P value of ≤0.2 were included in binary logistic regression model to identify independent associations with blood transfusion. A $P < 0.5$ was taken as statistically significant.

RESULTS

A total of 292 units of packed red cells were ordered preoperatively, but only 66 units were transfused; this

Table 2: Amount of blood cross matched and the frequency of transfused along with the C/T ratio in patients undergoing elective spinal arthrodesis at our center

Variable	Number of patients with cross matched blood	Number of patients requiring transfusion	Percentage	*P* value
Age group				
<40 years	39	21	53.8	0.175
>40 years	46	18	39.1	
Gender				
Male	45	18	40.0	0.248
Female	40	21	52.5	
Preop hemoglobin				
>9.0 g/dl	73	30	41.1	0.029
<9.0 g/dl	12	9	75.0	
Indication for surgery				
Degenerative	40	9	22.5	<0.001
AIS	13	9	69.2	
Trauma	17	9	52.9	
Infectious	5	3	60.0	
Others	10	9	90.0	
Comorbidities				
Yes	24	10	41.7	
No	61	29	47.5	0.625
Surgical approach				
Anterior	27	4	14.8	<0.01
Posterior	45	27	60.0	
Circumferential	7	5	71.4	
Lateral	6	3	50.0	
Specific region of spine				
Cervical	28	3	10.7	<0.001
Cervicothoracic	3	1	33.3	
Thoracic	6	4	66.7	
Thoracolumbar	21	15	71.4	
Lumbar	27	16	59.3	
No. of levels decompressed				
≤2 levels	75	32	42.7	0.172
>2 levels	9	6	66.7	
No. of levels of arthrodesis				
≤2 levels	34	10	29.4	0.021
>2 levels	49	27	55.1	

*The Chi-square statistic is significant at the 0.05 level. AIS: Adult idiopathic scoliosis

resulted in a 4.4:1 C/T ratio. Patients undergoing elective spine arthrodesis for degenerative spine disease had the highest C/T ratio of 6.9:1 followed by 5:1 for infectious etiologies, 3:1 for AIS, and 2.7:1 for trauma. Similarly, when considering percentage of patients requiring blood transfusion 69.2% (n = 9) of patients undergoing surgery for AIS required transfusions, followed by 60%, (n = 3) for infectious indications, 52.9% (n = 9) for trauma, and 22.5% (n = 9) for degenerative spinal disease. When considering the level of spinal surgery, patients having surgery of the cervical spine had the highest C/T ratio of 23:1 followed by 5.8:1 for thoracic spine, 3.8:1 for thoracolumbar junction, and 3:1 for lumbar spine. When considering the number of patients requiring transfusion by region of spine 71.4% (n = 15) of patients undergoing thoracolumbar surgery required transfusions, followed by 66.7% (n = 4) for thoracic, 59.3% (n = 16) for lumbar, 33.3 (n = 1) for cervico-thoracic, and 10.7% (n = 3) for cervical spine.

Table 3: Multivariate analysis of factors associated with a higher risk of transfusion in patients undergoing elective spinal arthrodesis at our center

	Adjusted odds ratio (95% CI)	*P* value
Age group (years)		
<40	1	
≥40	6.037 (0.55-66.11)	0.141
Preop hemoglobin		
Normal	1	
Lower than normal	4.39 (0.55-35.25)	0.164
Indication for surgery		0.027
Degenerative	1	
AIS	124.87 (3.05-5116)	0.011
Trauma	34.37 (1.92-616)	0.016
Others	358.26 (7.51-17098)	0.003
Surgical approach		0.654
Anterior	1	
Posterior	2.19 (0.12-38.69)	0.593
Other	0.69 (0.03-17.39)	0.823
Specific region of spine		0.314
Cervical	1	
Cervicothoracic	2.28 (0.085-60.91)	0.624
Thoracolumbar	5.54 (0.18-174.41)	0.331
Lumbar	21.03 (0.786-562.80)	0.069
Levels decompressed		
≤2 levels	1	
>2 levels	9.81 (0.60-160.47)	0.109
Levels of arthrodesis		
≤2 levels	1	
>2 levels	0.55 (0.09-3.20)	0.503

CI: Confidence interval

Univariate analysis for factors associated with higher risk transfusion

In the univariate analysis, factors associated with a higher risk of blood transfusion ($P \leq 0.20$) included; preoperative hemoglobin less than or equal to 9 g/dl, increased requirements for spinal trauma and AIS surgery, fusions including the thoracolumbar spine, and more than

two-level decompressions and/or arthrodesed [Table 1]. When these factors were included in the binary logistic regression model, the only factor that was independently associated with blood transfusion was the indication of surgery ($P < 0.05$) [Table 2]. The model revealed AIS to have an adjusted odds ratio of 124.87 when compared with degenerative spine disease. Similarly trauma had an adjusted odds ratio of 34.37.

DISCUSSION

Spine decompression and fusion with instrumentation is now a common procedure in the treatment of various pathologies of spine, including degenerative disease, trauma, and scoliosis. However, advances in surgical and anesthetic techniques and perioperative management have significantly reduced the operative blood loss but have not eliminated operative transfusion requirements.[9]

Nevertheless, there are no uniform guidelines regarding the appropriate amount of blood that should be ordered prior to spinal procedures. This results in the discarding or waste of cross matched but unutilized blood, thus incurring increased operative costs while depleting a vital resource.

In our study we found that majority of the cases did not require blood transfusions and the amount of blood cross matched far exceeded the requirement. Out of 292 units of packed red cells cross matched for our cohort of 85 patients only 66 units were transfused to 39 patients, indicating that only 45.88% of patients required blood transfusions. This was indeed an eye-opener for in a developing country such as ours, where healthcare is already restricted due to financial constraints, such a large wastage of valuable resource including time, money, equipment, personnel, and storage space; carried on unnoticed daily for years. This was especially true for surgeries done for routine degenerative spine pathologies (lumbar laminectomy, microdiscectomy, cervical laminectomy, anterior cervical discectomy, etc.). These incidentally are also the most frequent elective spine cases and by and large do not require perioperative transfusions. We found the C/T ratios to be unacceptably high (22.5%, C/T ratio of 6.9:1) indicating a fundamental flaw in our blood ordering practice. An introduction of a protocol would therefore be most beneficial for this group of patients.

We also found a trend that lower regions of the spine (thoracic, thoracolumbar, lumbar) were more likely to require transfusion compared with cervical spine, which is understandable given the anatomical differences. However, even for lower spine, our C/T ratio was above the optimal 2:1 reported in literature.[1]

Our findings concur with that of the Torres-Claramunt *et.al.* study, where patients undergoing elective spinal arthrodesis have excessive amounts of blood arranged, which go unutilized.[8] While mentioning their limitations, Torres-Claramunt *et.al.* pointed out that they did not include patients undergoing surgery for AIS considering the complexity of the procedure and the extensive amount of blood loss. Upon including AIS patients in our study, we found that even though they did have significantly higher needs for transfusion (odds of 125:1) when compared with those having surgery for degenerative spinal disease, their cross match to transfusion was only slightly higher (3:1) than the acceptable ratio reported in literature (2:1). It should be mentioned here that the sample size for AIS in our study is small.

Our study variables were selected after a comprehensive literature review, and even though little has been published on this topic, a number of variables have been proposed to have association with increased transfusion requirements. These include low preoperative hemoglobin, history of pulmonary disease, surgery for tumors, increased number of spinal levels fused, female sex, age more than 60 years, and a preoperative ASA score of 3.[3,6,8] These variables were filtered and independently analyzed to look for possible predictive factors for transfusion. The eventual objective was to design a protocol for blood ordering specifically addressing different types and complexities of spine surgeries. Of these factors, only indication of surgery was significant in our multivariate model. However, we realize that the numbers in some of our subgroups are too small for the multivariate analysis to be clinically relevant. For example, Nuttall *et al.* reported that arthrodesis associated with removal of tumors is associated with a greater risk of transfusion and therefore it was included as a study variable.[6] On multivariate, our findings matched with that of Nuttall *et al.* as we also noticed significant odds of transfusion with tumors in our series. These cases, however, made up of only approximately 2% of our study sample, which prevented us from drawing any meaningful conclusions from these findings. Therefore, for practical purposes, the results of univariate analysis had to be considered sufficient for recommendations.

Based on the univariate analysis, we recommend two units packed cells to be arranged for patients with preoperative hemoglobin levels <9 g/dl, trauma and AIS cases, or where more than two levels are being decompressed and/or arthrodesed. For the remaining cases, a group and hold policy should be sufficient. Obviously, these recommendations are not applicable to patients undergoing extensive surgery, and patients with preexisting coagulation disorders.

Even though our recommendations appear reasonable, our study is limited by a small sample size, a retrospective design, and a case mix representing our institutional catchment and practice trends. These findings can therefore not be generalized. Moreover, due to the small sample size, not enough numbers were present in subgroups to complete a meaningful multivariate

analysis, such as that for AIS or tumor cases. We would therefore recommend a larger, prospective multicenter study to validate our recommendations.

CONCLUSION

We found unacceptably high C/T ratio at our institution, especially when arthrodesis was planned for degenerative disease or cervical spine. Based on univariate analysis, we recommend two units packed cells to be arranged for patients with preoperative hemoglobin levels <9 g/dl, trauma and AIS cases, or where more than two levels are being decompressed and/or arthrodesed. For the remaining cases, a group and hold policy should be sufficient.

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