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Abstract

Background: On the basis of an institutional audit, the authors published an individual patient-based protocol for preoperative arrangement of blood products in patients undergoing elective spine arthrodesis. The present study was conducted for the prospective validation of the proposed protocol in reducing cross match to transfusion ratio, and its implications on overall cost.

Methods: This cross-sectional study was conducted over 1 year (2012). All adult patients who underwent elective spinal arthrodesis were included and prospectively observed. The actual transfusion index was calculated for individual patients with the formula C_1/T, where C_1 is the number of units of packed RBCs cross matched and T is the number of actual transfusions. C_1/T was then compared with a theoretical transfusion index C_2/T for the same group of patients, C_2 being the number derived from calculating the number of units of packed RBCs that would have been ordered for individual patient according to the protocol. The cost difference between C_1/T and C_2/T was analyzed.

Results: A total of 125 patients were included. A total of 435 units of packed RBCs were ordered (C_1), out of which only 108 units were transfused (T), yielding a C_1/T of 4.02. The C_2 for the same group of patients was 188 units of packed RBCs and the C_2/T was thus calculated to be 1.74. Implementation of the protocol would reduce per patient cost from Pakistani Rupees (PKR) 6676.8 ± 4125.8 to 4700.8 ± 1712.86, with a $P < 0.001$ and an overall reduction of 30%.

Conclusion: Cross match to transfusion ratio and blood ordering related cost are both significantly reduced with the application of institutional cross-match protocol.

Key Words: Blood transfusion protocol, spinal arthrodesis, spinal decompression

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INTRODUCTION

The cross match to transfusion (C/T) ratio or the transfusion index is a simple and reliable indicator of the accuracy of preoperative assessment of expected transfusions for an individual patient undergoing a particular surgical procedure. It has been repeatedly stressed that patients undergoing elective spine arthrodesis tend to have more blood products arranged than what would be eventually required, therefore generally yielding a high transfusion index.[7,11,12] This not only puts extra workload on often busy blood banks, but

also adds to the overall hospital costs.[3,4,11] This waste is particularly relevant for developing countries where resources are scarce and must be utilized judiciously. The present study attempts to validate our protocol regarding preoperative assessment/calculation of transfusions requirements, with an aim of limiting perioperative waste of blood products, while reducing cost.

METHODS

This is a prospective cross-sectional study conducted at a university teaching hospital in Karachi, Pakistan over 1 year (2012). Ethical considerations were addressed as per the Declaration of Helsinki.[14] We followed our published protocol for preoperative determination of transfusion requirements in patients undergoing elective spinal fusions. Variables considered included preoperative hemoglobin ≤9.0 mg/dl, specific indications for surgery, surgery for thoracic or lumbar spine, two or more levels of decompression, and/or arthrodesis, which were the factors associated with increased odds of transfusion.[1]

All adult patients undergoing elective spinal arthrodesis during this period were included based on our published protocol.[1] The following patients were excluded: Those undergoing non-instrumented fusion, multiple surgeries, revision procedures, and tumor resections. We prospectively analyzed the following factors: Number of transfusions and the frequency of ordering of blood products.

A total of 125 patients underwent elective spine arthrodesis in the study period; 53.6% (*n* = 67) of the patients were male. Seventy-six (60.8%) patients had fusion done at more than two levels. Degenerative spine disease was the commonest indication in 45.6%, followed by adult idiopathic scoliosis (AIS; 21.6%) and trauma (17.6%).

The data were prospectively collected utilizing patient's records, blood bank requests/utilization data, and ongoing clinical care. A theoretical cross-match number was calculated for each patient based on the protocol, considering factors such as age, gender, preoperative hemoglobin, number of levels decompressed, and number of levels fused (proportions, means, and standard deviations were also calculated for continuous variables, while paired sample *t*-tests were applied to estimate the significance of the difference between mean numbers of packed RBCs cross matched and transfused).

The actual transfusion index was calculated for individual patients utilizing the formula C1/T, where C1 is the number of units of packed RBCs cross matched and T is the number of actual transfusions. C1/T was then compared with a theoretical transfusion index C2/T for the same group of patients, where C2 is the number derived from calculating the number of units of packed

RBCs that would have been ordered for individual patient utilizing our protocol. Cost of transfusion was calculated for each patient using the formula: Cost of one unit × number of units. Total cost and theoretical costs were calculated using the following formulae:

Total cost = cost of 1 unit transfused × number of units + cost of 1 unit cross matched × number of cross-matched units

Theoretical cost = cost of 1 unit transfused × number of units + cost of 1 unit cross matched × theoretical number of cross-matched units

Cost was expressed in Pakistani Rupees (PKR). The two costs were compared using paired sample *t*-test. All the analyses were performed using SPSS v 19 IBM Chicago IL. Significance was assumed at a *P* < 0.05.

RESULTS

Characteristics of the study population are given in Table 1. A total of 435 units of packed RBs were ordered and transfused preoperatively. Out of this number, only 108 units of packed RBCs were transfused. Ratio of cross match to transfusion (C1/T) was very high, i.e. 4.02 [Table 2]. This could be significantly lowered by applying our transfusion protocol, i.e. to 1.74 [Table 2].

The cost of arranging and transfusing blood could be reduced significantly by following our protocol of cross match [Table 2].

DISCUSSION

With a per capita income of PKR 131,543 (2013), Pakistan is classified by the World Health Organization as a low-/middle-income country. Cost is a serious consideration for our patients, especially in the private health sector where

Table 1: Population characteristics

Variables	Mean±SD/ numbers	Percentage
Population characteristics		
Age	38.5±18.6 years	
Male	67	53.7
Female	33	46.3
Preoperative hemoglobin≤9 mg/dl	5	4
Number of levels decompressed≥2	9	7.2
Number of levels fused ≥2	76	62.8
Indication of surgery		
Trauma	22	17.6
AIS	27	21.6
Infection	6	4.8
Degeneration	57	45.7
Others	13	10.4

Hb: Hemoglobin, AIS: Adult idiopathic scoliosis, SD: Standard deviation

Table 2: Analysis of difference in units of packed RBCs arranged and transfused

Variable	Actual	Theoretical	Difference	Significance
Units cross matched	435 (C1)	188 (C2)	247	<0.001
Units cross matched per patient	3.62±3.12	1.41±0.91	2.21	<0.001
Units transfused	108 (T)	108 (T)	-	-
Cross match to transfusion ratio	4.02 (C1/T)	1.74 (C2/T)	2.28	
Analysis of difference in cost (PKR)				
Total cost of arrangement (A)	327,000	80,000	247,000	<0.001
Cost of arrangement per patient (a)	2616	640	1486	<0.001
Total cost of transfusions (B)	507,600	507,600	-	-
Cost of transfusions per patient (b)	4060	4,060	-	-
Sum total cost (C=A+B)	834,600	587,600	247,000	<0.001
Sum total cost per patient (c=a+b)	6676	4700	1976	<0.001

PKR: Pakistani Rupees, RBCs: Red blood cells

without state support and insurance companies, expenses are borne by the patients themselves.[8] Therefore, we must identify areas where costs could be significantly cut without impacting the quality of care. High cross match to transfusion ratios have been recognized for elective surgery, in general, and for spinal fusions, in particular.[1,2,4,13] This is primarily attributed to the lack of adequate institutional protocols. Few evidence-based guidelines are available in the literature, and even fewer have been validated or accepted internationally. Our paper constituted an important step toward prospective validation of an evidence-based protocol for ordering blood in elective spine fusion patients. In our study, implementing our recommended protocol reduced the cross match to transfusion ratio from 4.02 to 1.74; this reduced both total blood bank cost and the per patient blood bank related costs.

Other papers have similarly addressed the cost-effectiveness of a protocol-based arrangement of blood products for elective surgeries. The concept of Maximum Surgical Blood Order Schedule (MSBOS) was previously developed and implemented in other developed countries,[5,6] and has resulted in significant cost reduction while changing practices for "routinely" or "unnecessarily" ordering blood.[9,10] Previously, Chawla *et al*.[4] analyzed the practice of ordering blood for various elective procedures including microdiscectomy.

Limitation of this study was that the used protocol was not based on multivariate analysis. However, the protocol proved reasonably safe and accurate; in our 125 patients, only 13 required more than two units of packed RBCs and none required more than two units in the immediate postoperative period. Nevertheless, variations in individual surgical techniques preclude a "one size fits all" approach,

and we, therefore, recommend multi-institutional validation of this protocol prior to acceptance.

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