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Utilization of banked blood in pediatric surgical procedures in Calabar, Nigeria

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ABSTRACT

Background: Performing major surgery in a child demands that blood is cross-matched and saved to be transfused as indicated. Because the cost of cross-matching and donation of blood can be enormous and may equal or surpass the cost of surgery in our setting, it is pertinent to evaluate its utilization. The aim of this study was to determine how banked blood meant for pediatric surgical procedures was utilized with the hope of streamlining our blood requisition policy. This may be useful to pediatric and other surgeons involved in the operative care of children in similar settings. **Materials and Methods:** This was a prospective study of all children who had ELECTIVE or EMERGENCY surgical procedures between January 2009 and June 2010. The age, sex, nature of surgery, blood loss, banked units of blood and amount transfused were collected and analyzed. **Results:** Eighty two patients had 81 units of blood banked for them. Forty – eight and half units (59.9%) of the banked blood were for the emergency group but only 18 units (22.2%) were actually transfused at the end ($P = 0.044$) leading to inadequate use of the product. **Conclusion:** Banking large quantities of blood but utilizing only little is tantamount to inadequate use and delays surgical intervention. Indirectly, it increases cost of surgery. There is need to rationalize our blood ordering habits without causing harm to patients.

Key words: Banked Blood, Calabar – Nigeria, pediatrics, surgical procedures, utilization

INTRODUCTION

Blood transfusion is common in surgical patients.[1] Although transfusion could be lifesaving, it can be associated with increased morbidity and mortality as well as increase cost of surgery. Therefore, current transfusion practices may require re-evaluation.[2,3] Given the small blood volume and size of the pediatric patient, small losses of blood are thought to have significant consequences.[4,5] Hence, blood replacement was recommended if blood loss exceeded 10% of the estimated blood volume (EBV).[6,7] This has led to the practice of cross-matching and banking blood whenever major surgical procedures were contemplated in children whether ELECTIVELY or as EMERGENCY. A major surgery is that which penetrates and exposes any body cavity or produces significant impairment of anatomical and / or physiological function with possibility of severe haemorrhage.[8] It is elective, when it is scheduled in advance in non – life threatening conditions and an emergency when it must be done promptly to save life, limb or functional capacity. Is banked blood adequately and properly utilized in major pediatric surgical procedures in our center and not merely increasing cost of surgery?

The aim of this study was to determine how banked blood was utilized during major elective and emergency surgical procedures in children in a developing economy such as ours and to suggest ways of maximizing its utilization. This, it is hoped will change blood transfusion requests practices during planning for major pediatric surgical operations as well as stimulate the need for fractionation of blood.

MATERIALS AND METHODS

This study was undertaken at the pediatric surgery unit of the Department of Surgery, University of Calabar Teaching Hospital (UCTH), Calabar, Nigeria. Consecutive children aged from birth to 15 years who had surgery whether ELECTIVELY or as EMERGENCY for which homologous blood was cross-matched and saved during an 18 month period, from January 2009 to June, 2010 were prospectively studied. Consent was obtained from the hospital's Research/Ethics Committee and from the patients' parents or guardians. Inclusion criteria used were age from birth to 15 years, major

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elective or emergency operation requiring banked homologous blood and parental consent. Patients who met the inclusion criteria but who had low Packed Cell Volumes (PCVs) had their anaemia corrected before being recruited into the study. However, older children and those who had surgical operations without banked blood as well as those without parental consent were excluded from the study. Based on the nature of surgery performed, the study population was divided into two groups - ELECTIVE and EMERGENCY.

At surgery, meticulous dissection and adequate haemostasis with diathermy were employed to minimize blood loss. Need for intraoperative transfusion was determined by amount of blood in soaked gauze swabs, abdominal packs, suction bottle as well as the clinical state of the patient.[6,7]

The following data were collected - age of patients, sex, diagnosis, nature of surgery, amount of blood loss, amount of blood cross matched, transfused or returned and the reasons for return. The data were entered in a pre-designed proforma. Data analysis was done using SPSS Version 14 for windows. Two sample Chi-square was used to achieve comparison of the two groups. Statistical significance was defined as $P<0.05$. The programme software added 0.0000001 to zero cells to permit computation. Adequate blood utilization was defined as a Cross-match (C) to Transfusion (T), C/T ratio of < 2.5[9] and Transfusion Index (TI) of 0.5.[10] The Cross-match to Transfusion ratio is defined as the number of red cell units cross-matched over number of units transfused while the Transfusion Index is the number of units transfused over number of patients cross-matched.

RESULTS

There were two study groups, ELECTIVE and EMERGENCY with a total of 82 patients. Thirty two (39.0%) patients were in the elective group, 13 (15.9%) of whom were males and 19 (23.1%) females (M : F = 0.7:1), while the emergency group had 50 (61.0%) patients, made up of 33 (40.3%) males and 17 (20.7%) females (M : F = 1.9:1). The age range at presentation was one week to 15 years with a median age of 2.0±4.73 years. Twenty-seven (32.9%) of those who had emergency surgeries and eight (9.8%) of those who had elective operations were infants who altogether constituted more than one-third (n=35; 42.7%) of the total population of patients [Table 1].

The predominant disease conditions found in these patients were – Acute Intestinal Obstruction from various causes (28), High anorectal anomaly (12), Hirschsprung's disease (8), Typhoid enteric perforation (7), Wilm's tumor (4), splenic rupture (3), intra-abdominal lymphoma (3), among others.

In all, 81 units (36,420 ml) of whole blood were cross-matched for 82 patients, a unit of whole blood being the equivalent of 450 ml.[11] Double units were cross-matched for two (2.5%) patients, while in six (7.4%) others, use of the pediatric blood bags enabled the donation of half unit each. Of the amount of blood cross-matched, 48.5 units (21,810 ml; 59.9%) were for patients in the emergency group, while 32.5 units (14,610 ml; 40.1%) were for those in the elective group [Table 2]. The range of estimated blood loss in the elective (50 – 500 ml, average 186 ml)

Table 1: Age distribution of children in the two study groups.

Age	Nature of surgery					*p*- value
		Elective		Emergency		
	Frequency	No. of pts	%	No. of pts	%	
0-1	35	8	9.8	27	32.9	$x^2 = 12.39$
1-5	22	15	18.3	7	8.6	$p = 0.006$
6-10	8	2	2.4	6	7.3	
11-15	17	7	8.5	10	12.2	
Total	82	32	39.0	50	61.0	

Table 2: Amount of blood (ml) saved for various patients

Unit Vol Donated (ml)	Nature of surgery						*p*-value
	Elective			Emergency			
	No of patients	Amount Saved	%	No. of patients	Amount Saved	%	
220	3	660	1.8	3	660	1.8	$x^2 = 3.629$
450	27	12,150	33.4	47	21,150	58.1	$p = 0.163$
900	2	1800	4.9	–	–	–	
Total	32	14,610	40.1	50	21,810	59.9	

was higher than that in the emergency (50 – 350 ml, average 138 ml) groups and this significantly determined the likelihood of a blood transfusion ($P < 0.001$).

Of the 82 patients cross-matched, 57 (69.5%) of them actually received blood transfusion out of which 20 (24.4%) and 18 (22.0%) constituting more than half the population, involved infants and preschool school aged children respectively. Infants in the emergency group (n =14; 17.1%) were two times more likely to be transfused than those in the elective (n= 6; 17.1%) group, while the likelihood of transfusion in the preschool aged groups was about equal. It was only in a few of the elective (n=7; 8.5%) and emergency (n=6; 7.3%) cases that the banked blood was completely used up. The others received varied amounts transfused mainly as whole blood.

The total amount of blood transfused was 34.3 units (15,420 ml; 42.30%). The blood usage in the elective group (n=16.3 units; 7,350 ml) when compared to that of the emergency group (n=18.0 units; 8,070 ml) appeared matched ($P = 0.090$) [Table 3] and statistically insignificant meaning that adequate pre-operative work-up must have minimized or eliminated the difference in blood usage between the groups.

In all, 25 (30.5%) and 32 (39%) children in the elective and emergency groups received blood transfusion, giving transfusion rates of 30.9% (25/81 units) and 39.5% (32/81 units) respectively. The cross-match to transfusion (C/T) ratio in the Elective (32.5/16.3 units) and Emergency (48.5/18 units) groups were 2.0 and 2.7 respectively. This indicated significant blood usage in the elective group. The transfusion Index (TI) of 0.51 and 0.36 in the Elective (16.3/32) and Emergency (18/50) groups respectively further indicate that blood utilization in the elective group was significant.

In fact the amount of blood not transfused in the emergency (n=30.5 units; 13,740 ml) group was about twice the volume transfused in either group and about equal the total amount of blood transfused in both groups [Tables 3 and 4].

Table 3: Amount of blood (ml) transfused in the various patients

Unit Vol of Transfn	Nature of surgery						*p*-value
	Elective			Emergency			
	No of patients	Amount transfd	%	No. of patients	Amount transfd	%	
*Nil	7	0	0	18	0	0	
100	1	100	0.3	5	500	1.4	
150	8	1200	3.3	5	750	2.1	$x^2 = 13.704$
200	7	1400	3.8	5	1000	2.8	$p = 0.090$
220	0	0	0	1	220	0.6	
250	1	250	0.7	6	1500	4.1	
350	1	350	0.9	4	1400	3.8	
450	5	2,250	6.2	6	2,700	7.4	
900	2	1800	4.9	0	0	0	
Total	32	7,350	20.1	50	8,070	22.2	

*Nil – means the cross-matched blood was not transfused

Table 4: Amount of blood (ml) not transfused in the various patients

Unit Vol not Transfd	Nature of surgery						*p*-value
	Elective			Emergency			
	No of patients	Amount not transfd	%	No. of patients	Amount not transfd	%	
*Zero	7	0	0	7	0	0	
100	1	100	0.3	4	400	1.1	
120	1	120	0.4		2	240	$0.7\ x^2 = 15.893$
200	1	200	0.5	6	1200	3.3	$p = 0.044$
220	2	440	1.2	0	0	0	
250	7	1,750	4.8	5	1,250	3.4	
300	8	2400	6.6	5	1500	4.1	
350	0	0	0	3	1050	2.9	
450	5	2,250	6.2	18	8100	22.2	
Total	32	7,260	20.0	50	13,740	37.7	

*Zero - means all cross-matched blood was transfused

The major reason for non-use of blood in the elective (n=18; 22.0%) and emergency (n=24; 29.3%) groups was that the blood was in excess of the amount actually required. In seven elective (8.5%) and 18 emergency (22.0%) cases, the banked blood was never required. It was only in one emergent case that banked blood was not used due to patient's demise.

DISCUSSION

The findings of this study showed that infants and preschool age children were those commonly diagnosed with major elective and emergency conditions requiring banked blood. Similarly, the study found that in major elective and emergency operations in children, infants and the preschool aged group were the most likely to be transfused with banked blood. This tendency has been attributed to the small total blood volume of the pediatric patients[6,7] such that even small losses of blood could have significant consequences. The normal estimated blood volume (EBV) for weight and age of children is 80 – 90 ml and 90 – 100 ml per kg for full and preterm neonates, respectively.[4,5,12] In older children, the EBV ranges from 70 to 80 ml per kg.[4,12] Blood replacement was therefore recommended if blood loss exceeded 10% of EBV[6,7] so as to avoid the untoward consequences of inadequate oxygen – carrying capacity that is caused by an inadequate Red Blood Cell (RBC) mass.[13] This practice led to more infants and preschool age children receiving blood transfusion in this study.

The results of the study showed that whole blood was the main form of blood used in all the patients in both the elective and emergency pediatric cases. This agrees with the observation of MacLennan *et al.*[14] that limited use of whole blood has continued despite a general move to blood component therapy in recent years. MacLennan found the indications for the use of whole blood to be primarily in pediatric practice, mostly for neonatal exchange transfusion and pediatric surgery. However, various blood - component products are being used increasingly in operations in children in industrialized countries[15] and in some emerging economies.[15] Such use of blood constituents no doubt maximizes the utility of banked blood and minimizes waste which should be the target of centers in the developing economies. There is, therefore, a compelling need to fractionate whole blood into specific components which can be tailored to the physiological needs of the pediatric patients in order to adequately utilize banked blood.

Comparative to the total amount of blood banked for each group, it could be argued that the utilization of banked blood was adequate in the elective and inadequate in the emergency groups. In fact the observed cross-match to transfusion ratio of 2.0[9] and the transfusion index of 0.51[10] are indications of adequate utilization of blood by patients in the elective more than emergency groups in this study. However, given the large volume of blood banked vis-à-vis the quantity actually utilized in both groups, it will be agreed that the overall blood use was less and its donation only tended to add to the cost of surgery. This agrees with the findings of Kagu *et al.*[16] in North Eastern Nigeria that blood use was least for pediatric surgical cases. This implies that blood transfusion practices and blood - banking services targeted at children should be so adapted as to maximize blood utilization. Whereas the transfusion guidelines for non-neonatal pediatric patients are similar to those for adults,[12,17] the overall blood volume to be transfused per patient is significantly different. Consequently, the amount banked should be individualized and tailored to patient size so as to lessen the burden of performing major surgery in children. This calls for the provision and use of pediatric blood bags so as to drastically reduce the amount of blood donated. This is, however, not the case in our center where there is a dearth of pediatric blood bags and so adult blood bags were utilized in all but six children leading to a large volume of donated blood out of which little was utilized in the end. This agrees with the finding of Smallwood[18] in elective general surgery where large amounts of blood were demanded but only little was used resulting in waste of resources.

The large amount of blood banked for the EMERGENCY group of which only little was utilized should allay the fears that often characterize major emergency surgical operations in children. It implies that adequate pre-operative work-up including correction of anaemia and careful haemostasis will minimize or even eliminate the need for intra-operative or post-operative use of blood products.

From the study, the reasons for nonuse of blood were:
i) More blood than was required.
ii) Blood that was not needed at all, and
iii) Patient's demise.

Banking more blood than was required was the single most important cause of nonuse of blood found in either the elective or emergency groups in this study. That blood cross-matched and banked for patients in the elective (8.5%) and emergency (23.2%) groups were never needed calls for reconsideration of our blood request policy. Just because a major surgical procedure is contemplated in a child is not enough

reason to cross-match and bank blood. This in some cases unduly delays surgical intervention. Rather, careful preoperative screening and work-up would aid in identification of who will actually benefit from banked blood so as to maximize use of product.

In conclusion, banked blood was adequately utilized in elective pediatric surgery cases but inadequately utilized in the emergency ones. The amount of blood utilization vis-à-vis the overall volume of banked blood appeared less resulting in large amounts of unused of blood. This indirectly added to the cost of surgery. Therefore, blood transfusion practices and blood - banking services targeted at children should be adapted to maximize blood utilization. This demands that the amount of blood saved should be individualized and tailored to patient size. Also, regular use of pediatric blood bags should be encouraged so that amount in excess of the volume required is not donated. Adequate pre-operative work-up including correction of anaemia and careful haemostasis are invaluable measures that must not be over-looked in major elective and emergency pediatric surgical procedures. There is a great necessity for fractionation and use of blood – components in our center so that patients receive only the necessary components while reserving other products for other children. To fully evaluate if banked blood is adequately and properly utilized and cost effective, a more expanded study is required.

KEY MESSAGE

Blood transfusion is common in pediatric surgical practice, but can be associated with increased morbidity and mortality as well as increased cost of surgery. Evaluation of its utilization will help streamline its requisition policy and eliminate delays in surgical intervention thereby maximizing its use.

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