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Blood component utilization before and after implementation of good transfusion practice measures in a pediatric emergency department

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ABSTRACT

Objectives: We aimed to determine the pattern of blood component utilization in pediatric Emergency Department (ED) and compare the utilization rate before and after the implementation of simple good transfusion practice measures.

Material and methods: This was a prospective pre/post interventional study conducted between February 2015 and April 2016. The study included 3 phases [1] Pre-intervention phase (6 weeks) consisting of baseline data collection [2] Intervention phase (3 months) involving education on transfusion triggers and periodic mailers about good practice and designated 'transfusion resident' for supervision. [3] Post- intervention phase (6 weeks) collecting data while continuing interventions.

Results: During pre-intervention, 379 blood components [Packed red cells(PRBC) - 227, Platelet concentrate(PC) - 78, Fresh Frozen Plasma(FFP) - 74] were requested for 280 children; 195 were transfused with an overall utilization rate of 51.5 %. PRBC had the poorest utilization rate (30 %) followed by PC (72 %) and FFP (96 %). About 79 % of the requisitions sent by residents in first training year were not utilized before intervention. Indications such as anticipated surgery, congenital heart disease, pneumonia and sepsis had lower utilization rate. Post intervention, there was 14 % reduction in blood component requests (325 requests in 258 patients). Both overall utilization rate (56 %) and PRBC utilization (37.4 %) showed improvement but the difference was statistically not significant.

Conclusions: Red blood cells were the most frequently requested blood components yet poorly utilized in ED. Simple interventions targeting providers in early stages of training could potentially improve the blood component utilization and transfusion practices in busy emergency departments.

1. Introduction

A safe and appropriate blood transfusion is an important therapeutic intervention in modern medicine. According to the WHO factsheet on blood transfusions, there are large variations between countries in the age distribution of transfused patients [1]. In the high-income countries, patients aged over 60 years are most frequently transfused, accounting up to 79 % of all transfusions. In contrast, about 65 % of transfusions in the low-income countries are for children under the age of 5 years. Blood for transfusion is a finite resource with limited period of viability. Therefore, blood and its various components become an extremely valuable commodity, requiring careful allocation to maximize clinical benefit [2,3]. This is especially important when it is used in acute care settings [4,5]. Despite extensive use in emergency settings, blood transfusion decisions are frequently made in absence of reasonable training, based on limited and low quality evidence alongside an often exaggerated anxiety towards anemia or bleeding. Overuse or inappropriate use of blood products leads to inadequacy of blood components and substantially increasing the cost of care.

Constant attempts are made to reduce unnecessary transfusions and several studies have been published from centres across the world regarding the practice of blood component transfusions [6–10]. Effects of multiple interventions on transfusion practices were studied in many of them but the data is mostly limited to adults. [11–17]. Studies on paediatric blood component usage and transfusion practices are very limited at present, especially in centres from low and middle income countries [18–20]. Our Pediatric Emergency Department (ED) is one of the largest centre in India with over 20,000 patient visits and about 11,000 admissions every year. Residents with different levels of post graduate training work in shifts supervised by consultants. At times,

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discordance in expertise among team members regarding the need, timing, and volume of transfusion may trigger a transfusion request which can go unutilized. This may adversely affect the availability of blood components for acute need in addition to increasing blood bank's work load and operating cost. This study was aimed to determine the extent of blood component utilization, factors affecting the utilization rate and whether a few simple measures as multimodal interventions can reduce the number of blood component orders and improve the utilization rate in a large tertiary care pediatric ED.

2. Methodology

This was a prospective pre/post interventional study conducted between February 2015 and April 2016 at the Pediatric Emergency Department of the Postgraduate Institute of Medical Education and Research, Chandigarh. Children ages 1 month to 12 years admitted to Pediatric ED for whom a blood component order was sent were included. Children in whom the order was sent for a planned transfusion outside ED (intraoperative transfusion, transfusion during hemodialysis etc.) were excluded. This study was approved by the institute ethics committee with a waiver of consent as the study involved only collection of existing de-identified data without direct patient interventions.

2.1. Procedure

The study was conducted in following three phases

2.1.1. Pre-intervention phase

Baseline data was collected over 6 consecutive weeks by twice daily visits. Details regarding the transfusion orders sent in the previous 12 h were recorded in a predesigned proforma, one proforma for each blood component order sent. The data was obtained from chart review and interviewing the residents that included clinical diagnosis, indications for blood component transfusion, timing of transfusion request, provider details, respiratory and hemodynamic status, number and type of blood components requested, number of each component issued from the Department of Transfusion Medicine (DTM), and outcome of the component issued (transfused or received back in the DTM). At the completion of phase-I, data collected from ED was matched and cross-checked with entries in the blood component register in the DTM and discrepancies sorted out.

2.1.2. Intervention phase

This phase lasted for 3 months and consisted of implementing good transfusion practice measures as following multimodal interventions:

1 The residents posted in Pediatric ED had fortnightly sessions using power point presentations regarding current consensus guidelines on transfusion triggers in critically ill children, standard guidelines for blood component transfusion in haematological disorders and best practices regarding ordering, usage, storage and traceability of blood components. A total of 52 residents received intervention, of whom 16 were in first training year, 19 in mid training year and 17 in final training year.
2 A written document on good practice was prepared and circulated through e-mail to the ED providers every month.
3 One of the senior residents in ED at each shift was designated as 'transfusion resident' who was available for guidance on any issues regarding blood transfusion.
4 A checklist containing information regarding the indication and the planned process of transfusion was prepared and kept in Emergency Department so that it could be filled for each blood component ordered. This checklist was included to serve as a reminder and reinforce the presence of appropriate indication for the blood component transfusion. However, feedbacks during review revealed that this process imposed additional burden on the residents working in the acute care area. The compliance in filling the checklist for every blood component ordered was not sufficient and hence it was not included in the study analysis.

2.1.3. Post-intervention phase

This period lasted for 6 weeks. Data was collected similar to pre-intervention, while the interventions performed in phase II were continued during phase III.

2.2. Statistical analysis

Categorical variables were described using frequencies as well as proportions. Differences in proportions between groups were tested for statistical significance using the Chi-square test or Fisher's exact test as appropriate. All tests were two tailed and p-value less than 0.05 was taken as significant. Data analysis was done on SPSS statistical software (version 20.0, IBM SPSS Statistics, USA).

3. Results

In the six weeks of pre intervention study period, 620 children aged between 1 month and 12 years were admitted to ED. A total of 379 blood component units were requested for 280 (45 %) patients during this period. The components include packed red blood cells [PRBC: n = 227, 60 %], platelet concentrate [PC: n = 78, 20.5 %] and fresh frozen plasma [FFP: n = 74, 19.5 %]. Out of 379 component units requested, 195 units were transfused with an overall utilization rate of 51.5 %. PRBC was the most frequently requested blood component but had the poorest utilization rate (n = 68, 30 %). FFP was the most utilized; nearly 96 % (71 out of 74) of all units requested were transfused.

Table 1 shows the comparison of group that received blood component transfusion with those in whom a blood component was requested but not transfused. During pre-intervention phase, children who were not transfused were younger, less frequently on respiratory or vasoactive support and had higher haemoglobin /platelet count at the time of blood component request. Clinical indications such as anticipated surgery, congenital heart disease, pneumonia and sepsis had poor utilization rate, with more than two third of all requisitions being not utilized. The time of blood component request did not impact the utilization rate, however request made by the residents in their early years of training were less likely to be utilised than those sent by their senior counterparts. About 79 % of the blood component orders sent by residents in first training year were not utilized as compared to only 20 % that were sent by residents in their final year of training (p = 0.001).

Post intervention, despite the increase in total ED admissions (n = 680), the proportion of children in whom a blood component was requested (n = 258, 37 %) had decreased by 8 % (Table 2). A total of 325 component units were requested and 182 were transfused with a marginal improvement in overall utilization rate (56 %) (p = 0.25). A higher proportion of PRBC (37.4 % vs 30 %, p = 0.10) and PC (84.2 % vs 71.8 %, p = 0.08) requests were utilized post intervention while the utilization rate of FFP remained (95.3 % vs 95.9 %) high and unchanged. During post intervention phase, the haemoglobin level and clinical indications for blood component requests were similar to pre intervention, however, sepsis, pneumonia and congenital heart disease showed better utilization. The trend in utilization rate for residents at different levels of training before intervention did not change post intervention, though the number of orders sent by residents in first training year showed a decline.

4. Discussion

In this quality improvement study in a tertiary referral ED, we aimed to investigate the pattern of transfusion requests and assessed the influence of transfusion knowledge, attitude and practice parameters on blood component utilization. Our study showed that more than one

Table 1
Comparison of transfused and not transfused blood component requests during pre and post intervention phases.

Parameter	Pre- intervention phase				Post- intervention phase			
	Total	Transfused	Not transfused	P value	Total	Transfused	Not transfused	P value
Total blood component requests	379	195	184		325	182	143	
PRBC	227	68	159		206	77	129	
PC	78	56	22		76	64	12	
FFP	74	71	3		43	41	2	
Age, years [median (IQR)]	3	4 (0.9–9)	2 (0.6–6)	0.013	4 (1–7)	4 (1–7)	3.5 (0.8–7)	0.33
Hb at the time of PRBC request (g/dL) Mean (SD)	7.8 (3.2)	5.2 (1.5)	9.7 (1.9)	< 0.001	7.5 (3.3)	5.4 (2.9)	9.5 (2.2)	< 0.001
Platelet count at the time of PC request (cells/$mm^{3)}$ Median (IQR)	11500 (6750–22250)	11000(5500–17500)	24000(21000–43000)	0.006	11000 (5000–16000)	10000 (5000–13000)	38500 (16000–58500)	< 0.001
Clinical indications								
Hemato-oncological disorders	136	92	44 (32 %)		117	77 (66 %)	40 (34 %)	
Acute bleeding	(36 %)	(68 %)	6 (17 %)		(36 %)	19 (90 %)	2 (10 %)	
Pneumonia /sepsis	36 (9.5 %)	30	72 (67 %)		21	33 (41 %)	47 (59 %)	
Congenital heart disease	107	(83 %)	12 (80 %)		(6.5 %)	4 (29 %)	10 (61 %)	
Anticipated surgery	(28.2 %)	35	22 (92 %)		80	1 (6 %)	15 (94 %)	
Others	15 (4 %)	(33 %)	28 (46 %)		(24.5 %)	48 (62 %)	29 (38 %)	
	24 (6.3 %)	3			14 (4 %)			
	61 (16 %)	(20 %)			16 (5 %)			
		2 (8 %)			77 (24 %)			
		33						
		(54 %)						
Respiratory and vasoactive support								
Children on respiratory support	107	80 (74 %)	27 (26 %)	< 0.001	69	35 (51 %)	34 (49 %)	0.25
a) O2 supplementation through nasal cannula, n (%)	64	47 (73 %)	17 (27 %)	< 0.001	52	24 (46 %)	28 (54 %)	0.67
b) Bubble CPAP, n (%)	8	7 (87 %)	1 (13 %)	0.068	1	0	1 (100 %)	1.0
c) Positive pressure ventilation, n (%)	35	26 (74 %)	9 (26 %)	0.004	16	11 (69 %)	5 (31 %)	0.12
Children on vasoactive support, n (%)	45	34 (76 %)	11 (24 %)	< 0.001	26	18 (70 %)	8 (30 %)	0.04
Time of request								
8 AM - 8 PM (Day), n (%)	257	137 (53 %)	120 (47 %)	0.22	221	124 (56 %)	97 (44 %)	0.70
8 PM - 8 AM (Night), n (%)	122	58 (47.5 %)	64 (52.5 %)		104	58 (55 %)	46 (45 %)	
Experience of the resident								
First training year, n (%)	72	15 (21 %)	57 (79 %)	0.001	18	5 (28 %)	13 (72 %)	0.012
Mid training year, n (%)	214	106 (49 %)	108 (51 %)		128	61 (47 %)	67 (53 %)	
Final training year, n (%)	93	74 (80 %)	19 (20 %)		179	116 (65 %)	63 (35 %)	

third of all ED admissions had a blood component request and about 20 % were transfused. The high transfusion rate at our institution could be due to severity of illness, prevalence of baseline anemia and a significant proportion of admissions with hemato-oncological disorders. The demand for PRBC was the most frequent, followed by FFP and PC in both pre and post intervention phases. This trend is consistent with the previous reports where PRBC often remained the frequently requested blood component [9,21,22]. The proportion of component usage

Table 2
Comparison of blood component utilization before and after intervention.

	Pre intervention	Post intervention	P value
Number of study days	42	42	
Total ED admissions	620	680	
No. of children for whom blood components requested	280	258	
Blood component request rate (No. of children for whom blood components requested / total admissions) (%)	45	37	0.009
No. of patients who received transfusion	128	119	
Blood component transfusion rate (No. of children who received transfusion / total admissions) (%)	21	18	0.15
Total number of blood components requested	379	325	
PRBC requests, n (%)	227 (60 %)	206 (63 %)	
PC requests, n (%)	78 (21 %)	76 (23 %)	
FFP requests, n (%)	74 (19 %)	43 (17 %)	
Total number of components transfused	195	182	
PRBC transfused, n (%)	68 (35)	77 (42)	
PC transfused, n (%)	56 (29)	64 (35)	
FFP transfused, n (%)	71 (36)	41 (23)	
Overall utilization rate (Components transfused / components requested) (%)	51.5	56	0.25
PRBC utilization rate (%)	30	37.4	0.10
PC utilization rate (%)	71.8	84.2	0.08
FFP utilization rate (%)	95.9	95.3	0.87

however differs with the type of clinical facility and availability of resources. Whole blood is still being transfused preferentially in facilities that are resource limited and care for trauma and surgical patients [23].

We found that the utilization rate of PRBC was poor and only marginally improved with implementation of simple educational interventions. Knowledge gap on optimal hemoglobin (Hb) threshold as a 'transfusion trigger' in contemporary acute care is an important factor. The target Hb for a PRBC transfusion is being lowered and the world is moving towards restrictive transfusion policy in ICU settings. A Canadian group in a randomized trial found better clinical outcomes with restrictive strategy of red cell transfusion (transfusing patients with a Hb < 7 g/dL) compared to a more liberal approach (transfusing patients with a Hb < 10 g/dL). [24] Similar findings were noted in children with cardiac disease where liberal transfusion practice did not show any benefit [25]. Both these studies were done in intensive care settings and included patients who were classified as 'clinically stable'. However, the clinical settings in ED differ from ICU in several ways. Firstly, non-availability of Hb or hematocrit values at the time PRBC request could be a major limitation. As the objective laboratory values may take some time, it is the subjective assessment of pallor at the first contact in ED that could have determined the request. Secondly, uncertainty about the transfusion triggers in ED setting especially when the clinical definition of 'stability' remains ambiguous and dynamic as compared to ICU had also played a role in unnecessary or excessive requests and poor utilization. Conditions like severe sepsis, pneumonia, congenital heart disease and surgical conditions with anticipated blood loss were the main indications for which a PRBC was requested but was less frequently transfused possibly due to the uncertainty in judging the need at the time of request.

Transfusion services in hospitals around the world have used various interventions to reduce the utilization of blood products. A large study in the UK Emergency Department assessed the demographics of transfusion including the patterns of blood component requests, transfusion and traceability before and after implementation of simple improvement strategies [10,11]. Baseline data during the year 2007 analysing 3209 blood component requests showed a utilization rate of 39.5 % with 9.5 % unaccounted units. The interventions included formal staff education, use of e-learning module, provision of dedicated ED transfusion staff and a blood refrigerator in resuscitation room. After intervention, blood component requests decreased by 64 % (3209 vs 1034 units) and transfusion decreased by 39 % (1131 vs 687 units) with a 96 % reduction in unaccounted units (214 vs 9 units). The low baseline utilization rate observed in this study was similar to our data, however, it differed from our study on two accounts; it was done over a longer duration with larger number of patients and the interventions were multimodal and sustained. A recent systematic review examining the impact of different behaviour modification interventions on transfusion practices showed reduction in inappropriate transfusion by 54 % [OR 0.46 (95 % CI 0.36 to 0.59)] however was unable to conclude with certainty which intervention was the most effective at modifying transfusion practice [26].

An important observation in our results during both pre and post intervention phases was the influence of level of training of ED residents on blood component utilization. Requisition sent by residents in early stages of training are more likely to be poorly utilized, while utilization rate proportionately improved with increase in level of training. The result suggests that education measures targeting trainees in early stage and providing them guidance in assessing the need for transfusion may help preventing many inappropriate transfusion requests. We observed a significant reduction in the number of requests particularly among first year residents with improved utilization following our interventions. It was also noted that children who were receiving vasoactive drugs and those on ventilator support were more likely to get transfused after a blood component request. Overall blood component utilization rate in them was > 70 % which was primarily attributed to increase in PRBC utilization. Electronic registry to accurately monitor the utilization with documented reasoning for non-utilization can facilitate reduction of blood demand at the clinician level. Constant audit in the hospital by a committee dedicated to review blood ordering habits and crossmatch-transfusion ratio at blood bank level would improve the practice, reducing DTM's workload and operating cost.

Our study has several strengths. It is one of the very few prospective studies conducted exclusively on pediatric population in a large ED. We included all consecutive blood component requests in both phases. The study yielded very important information on quality improvement of transfusion process in similar settings. However, a few limitations need mention. Firstly, the study duration, specifically the shorter intervention period (3 months) was a major limitation. Studies have shown positive impact of behavioural interventions in changing practice if they were sustained for several years [12,14,16]. In addition, the compliance of study interventions could not be monitored individually and hence estimate of the effect in the post intervention phase could not be completely attributed to the interventional measures. Future studies over longer duration combining educational interventions during early training year and measures to assess residents' knowledge retention would help us understand the impact of interventional strategies.

5. Conclusions

Red blood cells are the most frequently requested blood components yet poorly utilized in pediatric Emergency Department. Simple educational interventions addressing specific transfusion triggers and targeting providers in early stages of training could potentially improve the blood component utilization and transfusion practices in busy emergency departments.

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Declaration of Competing of Interest

None.

CRediT authorship contribution statement

Ashish Sharma: Conceptualization, Data curation, Formal analysis, Methodology, Writing - original draft. **Karthi Nallasamy:** Conceptualization, Data curation, Formal analysis, Software, Supervision, Validation, Visualization, Writing - review & editing. **Ashish Jain:** Conceptualization, Data curation, Formal analysis, Methodology, Software, Supervision, Validation, Visualization, Writing - review & editing. **Vijai Williams:** Data curation, Formal analysis, Software, Supervision, Writing - review & editing. **Muralidharan Jayashree:** Conceptualization, Data curation, Formal analysis, Methodology, Software, Supervision, Writing - review & editing.

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