Original Article

DOI: 10.7860/NJLM/2023/62313.2778

Utilisation of Different Blood Components in Paediatric Patients: A Cross-sectional Study

Pathology Section

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ABSTRACT

Introduction: The term "blood component" refers to the separation of Whole Blood (WB) into packed red cells, platelet-rich plasma, Fresh Frozen Plasma (FFP), cryoprecipitate, and leukocytes. The practice of separating donated WB units into different blood components and supplying only those components to patients is now considered a standard practice in all blood banks. Therefore, regular auditing of blood usage and its components is essential to assess blood utilisation patterns.

Aim: The aim of this study was to analyse the distribution and appropriateness of blood and blood product transfusions in children aged 1-18 years.

Materials and Methods: A cross-sectional study was conducted over an 18-month period from December 1, 2014, to June 30, 2016, involving paediatric patients requiring blood and blood product transfusions, who presented to the Department of Paediatrics, Shri B.M. Patil Medical Hospital, Vijayapura, Karnataka, India. The study population consisted of children aged 1-18 years. Data from blood component requisition forms were collected, and reports of investigations such as pre-transfusion/post-transfusion haematological parameters, coagulogram, and peripheral smear were recorded. Predetermined criteria were used to assess each transfusion episode. The results were then analysed, tabulated, and expressed as a percentage. The appropriateness of Packed Red Blood Cell (PRBC), platelet, and FFP transfusions was estimated using predetermined criteria. Data from blood component requisition forms were collected, coded, tabulated, analysed, and expressed as a percentage.

Results: The study included 149 paediatric patients aged 1 to 18 years. Out of a total of 214 episodes of blood and blood component transfusions among the 149 patients, 102 episodes (47.7%) were WB transfusions, 67 episodes (31.3%) were packed red cell transfusions, 26 episodes (12.1%) were platelet transfusions, and 19 episodes (8.9%) were FFP transfusions. Out of the total 214 transfusion episodes, 126 (58.5%) were deemed appropriate, while 88 (41.5%) were deemed inappropriate. The most commonly inappropriately used component was WB, followed by platelets, FFP, and packed red cells. Inappropriateness of WB usage was primarily due to attempts to achieve haemostasis in bleeding patients, while sepsis was the most common indication for inappropriate platelet usage.

Conclusion: This audit highlights significant variation in transfusion practice patterns among paediatricians. The most common indications for usage were found to be achieving haemostasis, threshold haemoglobin concentration, and sepsis in children.

Keywords: Appropriateness, Blood utilisation pattern, Predetermined criteria

INTRODUCTION

Blood transfusions are frequently life-saving. Blood and its components have the property of causing adverse reactions in recipients and form a significant part of patient management treatment protocols [1-3]. Blood transfusion is an essential part of modern therapy and has proven its efficacy in saving lives in primary and secondary healthcare settings in developing countries. Knowledge among clinicians and intravenous therapists about the potential risks of blood component therapy is necessary to maximise the effectiveness, safety, and utility of these transfusions [2,3].

It is essential for the blood bank to evaluate and assess the existing trends of blood ordering and be able to fulfill the demand for this life-saving product [2]. It is always essential to weigh the risk of transfusion against the risk of not transfusing before prescribing blood or blood products to the patient. The liberal use of blood and its components is associated with increased morbidity due to fluid overload, increased risk of infection, and an unnecessary increase in the duration of hospital stay [1]. Clinical audit can provide necessary information for the improvement of transfusion medicine practice and thus forms an important part of the quality assurance program. It is a management tool for the assessment and justification of appropriateness and efficiency of transfusion therapy [3]. The importance of an internal audit and educational program is to emphasize the proper selection of blood components for patients and avoiding their overuse [2].

Therefore, to set ideal policies in all the blood-using specialties and to assess the blood utilisation pattern, it is essential to conduct a regular audit of the usage of blood and its components [2,3]. Judicious implementation of guidelines for the use of various blood components will ensure the availability of components to needy patients and may help to decrease their inappropriate use [1]. Potential problems with intravascular volume and difficulty with the administration of blood products require careful consideration of the patient's age and weight for transfusion in the paediatric age group. A correct diagnosis is, therefore, essential for their proper use. The present study will thus be useful to ensure the safe and appropriate use of blood and blood products and plan strategies to reduce unnecessary blood and component transfusion in children. Hence, the present study was aimed at analysing the distribution and appropriateness of the transfusion of blood and blood products in children aged 1-18 years.

MATERIALS AND METHODS

A cross-sectional study was conducted on paediatric patients requiring blood and blood product transfusions, who presented to the Department of Paediatrics, Shri B.M. Patil Medical Hospital, Vijayapura, Karnataka, India, from December 1, 2014, to June 30, 2016. The study was carried out after obtaining clearance from the Institutional Ethical Committee, with letter number 54/14.

Inclusion criteria: All patients between 1 and 18 years of age who received blood and blood components were included in the study.

Exclusion criteria: Patients younger than 1 year and those receiving cryoprecipitate transfusions were excluded from the present study.

Study Procedure

A detailed history and examination of patients were recorded in a predesigned proforma. Reports of investigations, such as pretransfusion/postransfusion haematological parameters, coagulogram, and peripheral smear, were also documented. Predetermined criteria were used to assess each transfusion episode, which are mentioned below [1, 4, 5].

1. **Criteria for Whole Blood (WB) transfusion:**
   - Exchange transfusion for Haemolytic Disease of the Newborn (HDN) and hyperbilirubinemia with a risk of kernicterus.
   - After cardiopulmonary bypass.
   - Extracorporeal Membrane Oxygenation (ECMO).
   - Massive transfusion (defined as transfusion of >1 blood volume in 24 hours).
2. **Criteria for Packed Red Blood Cell (PRBC) transfusion:**
   - Acute blood loss > 25% of blood volume.
   - Haemoglobin 4 g/dL or less (Haematocrit 12%) irrespective of clinical condition.
   - Haemoglobin 4-6 g/dL (Haematocrit 13%-18%) with features of hypoxia, acidosis causing dyspnoea, or impaired consciousness.
   - Haemoglobin 6-10 g/dL; vital signs and tissue oxygenation should be noted.
   - Haemoglobin <8 g/dL in the perioperative period, chronic symptomatic anaemia, or anaemia due to chemotherapy.
   - Haemoglobin <13 g/dL with severe cardiopulmonary disease.
   - Refractory anaemia not corrected by pharmacological agents (such as Vitamin B12, folic acid, iron).
   - Chronic haemolytic anaemia such as thalassemia/sickle cell disease.
   - Hyperparasitemia in malaria (>20%).
   - Bone marrow failure syndrome with haemoglobin <8 g/dL.
   - Haematocrit <30%, requiring Continuous Positive Airway Pressure (CPAP) or mechanical ventilation >0.35 Fraction of inspired Oxygen (FiO_2).
3. **Criteria for platelet transfusion:**
   - For prophylaxis, the platelet count should be maintained greater than 10,000/mm^3.
   - Platelet count greater than 20,000/mm^3 in the presence of bleeding.
   - Platelet count greater than 50,000/mm^3 is indicated for major surgeries/invasive procedures with significant bleeding risk.
   - Platelet count should be maintained greater than one lac/mm^3 for central nervous system bleeding/surgery.
4. **Criteria for Fresh Frozen Plasma (FFP) transfusion:**
   - Coagulation disorder associated with active bleeding.
   - Following transfusion of more than one blood volume over several hours.
   - Dilutional coagulopathy from massive blood transfusion.
   - Multiple coagulation factor deficiency.
   - Coagulation disorder in the preoperative state.
   - Disseminated Intravascular Coagulation (DIC) with bleeding.
   - In patients with hereditary angioedema requiring replacement of C1 esterase inhibitor.
   - Emergency reversal of warfarin effect.
   - Plasma exchange replacement fluid for thrombotic thrombocytopenic purpura.
   - Anticoagulant proteins antithrombin III and protein C and S.

The total number of episodes of transfusions was observed, and out of the total episodes, the number of episodes of appropriate and inappropriate transfusions was noted based on the aforementioned predetermined criteria.

STATISTICAL ANALYSIS

Data from blood component requisition forms were collected, coded, tabulated, analysed, and expressed as a percentage.

RESULTS

The study included 149 paediatric patients between the ages of 1 year and 18 years who presented to the study Institute. A total of 214 episodes of blood component transfusions were administered to these children, with some children receiving multiple transfusions. Out of the 214 episodes, 102 (47.7%) were Whole Blood (WB) transfusions, 67 (31.3%) were packed red cell transfusions, 26 (12.1%) were platelet transfusions, and 19 (8.9%) were Fresh Frozen Plasma (FFP) transfusions [Table/Fig-1].

Blood component	No. of transfusion episodes	Percentage (%)
Whole Blood (WB)	102	47.7
Packed Red Blood Cell (PRBC)	67	31.3
Platelet	26	12.1
Fresh Frozen Plasma (FFP)	19	8.9
Total	214	100

[Table/Fig-1]: Percentage distribution of blood component.

WB transfusions were mainly performed for 22 episodes (88%) of sepsis, 12 episodes (63.2%) of thalassemia, and 10 episodes (100%) of bleeding disorders. WB transfusions were deemed inappropriate for cases of congenital dyserythropoietic anaemia, iron deficiency anaemia, sickle cell anaemia, intraoperative cases, Protein Energy Malnutrition (PEM), and bleeding disorders. The inappropriateness rate for sepsis and liver disease was 22 (88%) and 4 (80%), respectively, while thalassaemia and myelodysplastic syndrome had inappropriateness rates of 12 (63.2%) and 2 (66.7%), respectively. Two (40%) episodes of inappropriate transfusions were observed for malaria [Table/Fig-2].

Diagnosis	No. of transfusion episodes	Appropriate	Inappropriate
Thalassaemia	19	7 (36.8%)	12 (63.2%)
Sepsis	25	3 (12%)	22 (88%)
Congenital dyserythropoeitic anaemia	5	0	5 (100%)
Iron deficiency anaemia	6	0	6 (100%)
Haemolytic anaemia	4	4 (100%)	0
Sickle cell anaemia	1	0	1 (100%)
Megaloblastic anaemia	2	2 (100%)	0
Myelodysplastic syndrome	3	1 (33.3%)	2 (66.7%)
Liver disease	5	1 (20%)	4 (80%)
Intraoperative	6	0	6 (100%)
PEM	7	0	7 (100%)
Dengue	2	2 (100%)	0
Malaria	5	3 (60%)	2 (40%)
ALL	2	2 (100%)	0
Bleeding disorder	10	0	10 (100%)

[Table/Fig-2]: Percentage inappropriateness of Whole Blood (WB) transfusion.
(PEM: Protein Energy Malnutrition; ALL: Acute Lymphoblastic Leukaemia)

PRBC transfusions were mainly performed for thalassemia, sepsis, and iron deficiency anaemia. A 100% inappropriateness rate was observed for haemolytic anaemia, and 20% of transfusions for

iron deficiency anaemia were deemed inappropriate [Table/Fig-3]. Platelet transfusions were most commonly administered for cases of dengue fever, followed by bleeding disorders, myelodysplastic syndrome, and sepsis. A 100% inappropriateness rate was observed for sepsis, while dengue fever and bleeding disorders had an inappropriateness rate of 25% [Table/Fig-4].

Diagnosis	No. of transfusion episodes	Appropriate	Inappropriate
Thalassaemia	28	28 (100%)	0
Congenital dyserythropoeitic anaemia	1	1 (100%)	0
Iron deficiency anaemia	10	8 (80%)	2 (20%)
Megaloblastic anaemia	1	1 (100%)	0
Haemolytic anaemia	1	0	1 (100%)
Sickle cell anaemia	1	1 (100%)	0
Malaria	2	2 (100%)	0
Bleeding disorder	3	3 (100%)	0
Sepsis	15	15 (100%)	0
Intraoperative	5	5 (100%)	0

[Table/Fig-3]: Percentage inappropriateness of PRBC transfusion.

Diagnosis	No. of transfusion episodes	Appropriate	Inappropriate
Bleeding disorder	5	4 (80%)	1 (20%)
Dengue	12	9 (7%)	3 (25%)
Sepsis	2	0 (0%)	2 (100%)
Myelodysplastic syndrome	3	3 (100%)	0 (0%)
Iron deficiency anaemia	1	1 (100%)	0 (0%)
Liver disease	1	1 (100%)	0 (0%)
ALL	1	1 (100%)	0 (0%)
Chronic kidney disease	1	1 (100%)	0 (0%)

[Table/Fig-4]: Percentage inappropriateness of platelet transfusion.
(ALL: Acute Lymphoblastic Leukaemia)

The primary indication for FFP transfusion was bleeding disorders, accounting for seven transfusion episodes. This was followed by sepsis, Von Willebrand disease, and dengue fever. A 75% inappropriateness rate was observed for sepsis [Table/Fig-5].

Diagnosis	No. of transfusion episodes	Appropriate	Inappropriate
Bleeding disorder	7	7 (100%)	0 (0%)
Sepsis	4	1 (25%)	3 (75%)
DIC	1	1 (100%)	0 (0%)
Von Willebrand disease	2	2 (100%)	0 (0%)
Myelodysplastic syndrome	1	1 (100%)	0 (0%)
Dengue	2	2 (100%)	0 (0%)
Liver disease	1	1 (100%)	0 (0%)
Iron deficiency anaemia	1	1 (100%)	0 (0%)

[Table/Fig-5]: Percentage inappropriateness of FFP transfusion.
(DIC: Disseminated Intravascular Coagulation)

Out of the total 214 episodes of blood and component transfusion, 88 (41.5%) were deemed inappropriate. Among the 102 episodes of WB transfusion, 76 (74.5%) were considered inappropriate. Out of the 67 episodes of packed cell transfusion, 3 (4.5%) were deemed inappropriate. Among the 26 episodes of platelet transfusion, 6 (23.1%) were judged inappropriate, and out of the 19 episodes of FFP transfusion, 3 (15.8%) were considered inappropriate [Table/Fig-6].

Component	Appropriate		Inappropriate		Total
	Episode	%	Episode	%	
WB	26	25.5	76	74.5	102
PRBC	64	95.5	3	4.5	67
Platelet	20	76.9	6	23.1	26
FFP	16	84.2	3	15.8	19
Total	126	58.5	88	41.5	214

[Table/Fig-6]: Distribution of appropriate and inappropriate transfusions.
(WB: Whole Blood; PRBC: Packed Red Blood Cell; FFP: Fresh Frozen Plasma)

DISCUSSION

Blood component therapy provides haemodynamic stability in critically ill children in the intensive care setting and, therefore, is a life-saving treatment [6]. The purpose of blood transfusion is to increase blood elements, improve flow rate, replace lost blood, and replenish missing clotting factors and immune system elements [7]. Appropriate use of blood is necessary to avoid unnecessary patient exposure to the risks of transfusion reactions and transmission of blood-borne infections, and to ensure the availability of blood for patients who truly need it [8]. According to the World Health Organisation (WHO), appropriate use of blood products is defined as 'transfusion of safe blood products only to treat a condition leading to significant morbidity or mortality that cannot be prevented or effectively managed by other means. The lack of consensus on the most suitable criteria for blood transfusion therapy, variations in blood component therapy guidelines, and mixed effectiveness of strategies in changing transfusion practices contribute to wide variation in transfusion practices [9]. Correct blood transfusion indicates an increase in haemoglobin concentration, achievement of haemodynamic stability, and no harm to the recipient in terms of transfusion-related infections or adverse events [10]. Guidelines for children differ from those for adults due to considerations of growth and development [11]. Of the total 214 transfusion episodes, 102 (47.7%) episodes were for whole blood, 67 (31.3%) episodes for packed red blood cells (PRBC), 26 (12.1%) episodes for platelet concentrates, and 19 (8.9%) episodes for fresh frozen plasma (FFP).

Whole Blood (WB) and Packed Red Blood Cell (PRBC) Transfusion

In practice, whole blood (WB) is rarely available and infrequently used, typically reserved for situations such as massive bleeding leading to hypovolemia, massive trauma, and exchange transfusion. Urgent transfusion is recommended in cases where blood loss exceeds 40% of the blood volume or when signs of inadequate perfusion are present for blood loss between 30% and 40% of the blood volume [12]. In the present study, WB (47.7%) was the most frequently utilised component, followed by packed red blood cells (PRBCs) (31.3%), platelet concentrate (12.1%), and fresh frozen plasma (FFP) (8.9%). Studies by Efe S et al., Agrawal VP et al., and Gaur DS et al. also observed WB as the most frequently used component with data of 995 (50%), 632 (53%), and 550 (52%), respectively [7,13,14].

The overall prevalence of inappropriate use was 88 (41.5%) episodes. Out of the 102 episodes of WB transfusion, 76 (74.5%) episodes were judged inappropriate, while out of the 67 episodes of PRBC transfusion, 3 (4.5%) episodes were deemed inappropriate. WB was the component that was most inappropriately used, consistent with the findings of other similar studies [2,9]. The most common indication for blood transfusion in our study was found to be anaemia. WB was mostly received for sepsis, and PRBCs were mostly received for thalassemia. The most common reason for inappropriate WB transfusion in the present study was the attempt to achieve haemostasis in bleeding patients with normal platelet and coagulation profiles. The majority of inappropriate PRBC usage was due to apprehension of immediate risks to the patient and misperception of the role of PRBCs. A similar finding was observed in a study by Qureshi MZ et al. [15]. In the present study, PRBCs were used most appropriately, accounting for 64 (95.5%) episodes. This is in contrast to the study by Katara AA et al., who recorded 90% and 76.3% episodes of appropriate transfusion of WB and PRBCs, respectively [16].

For patients with a haemoglobin (Hb) level of 10 g/dL or higher, there is little need for blood transfusion based on clinical and laboratory data. Between 8-10 g/dL, the risk of hypoxic damage is generally low for most patients. Patients with an Hb level below 7 g/dL are usually at a substantial risk. Analysis of blood volume, cardiovascular, pulmonary, and cerebrovascular status, duration of anaemia, and likelihood of unexpected acute blood loss should be considered together to decide on red cell transfusion. In general, the decision to transfuse should always be based on the analysis of risk and benefit, taking into account two factors: 1) Evaluation of the patient's physiological needs, and 2) Transfusion of only blood products that meet those physiological needs [9].

Platelet Transfusion

In the present study, out of 214 episodes of blood transfusion, 26 (12.1%) episodes involved platelet transfusion. Among these, seven episodes were for platelet count <10,000/mm^3, five episodes were for platelet count 11-20,000/mm^3, 10 episodes were for count 21-40,000/mm^3, and four episodes were for count 41-100,000/mm^3. Six (23.1%) episodes with a platelet count >20,000/mm^3 in the absence of bleeding or sepsis received inappropriate transfusion. In a study conducted by Pallavi P et al., 26 (36.62%) episodes of inappropriate platelet transfusions were recorded [8]. In the present study, inappropriateness of platelet transfusion was observed in conditions such as sepsis (100%), dengue (25%), and bleeding disorder (20%). In a study carried out by Ahmed M and Save SU, inappropriate platelet transfusions were primarily observed in patients with dengue and thrombocytopenia without clinical bleeding and idiopathic thrombocytopenia without bleeding, as a prophylaxis to prevent bleeding [6]. The percentage of inappropriate platelet usage in the present study accounts for 23.1%. This percentage varies from the study conducted by Pallavi P et al., Sheikholeslami H et al., and Schofield WN et al., which accounted for 36.62%, 40.8%, and 33%, respectively [8,17,18]. In his study, Bhave AA concluded that platelet transfusion is not indicated in immune thrombocytopenic purpura (ITP) unless bleeding is present, asymptomatic thrombocytopenia, drug-induced thrombocytopenia, cardiac bypass-associated thrombocytopenia, and haemolytic uremic syndrome (HUS) or thrombotic thrombocytopenic purpura (TTP) [19]. In the present study, the appropriateness of platelet transfusion therapy was assessed in terms of clinical outcomes in a cohort of children. Platelet transfusion in children with a platelet count <20,000/mm^3 in the presence of bleeding was considered appropriate and compared to children who received platelet transfusion for counts >20,000/mm^3.

Fresh Frozen Plasma (FFP) Transfusion

In the present study, out of a total of 214 episodes of transfusion, 19 (8.87%) episodes involved fresh frozen plasma (FFP) transfusion. Among these, 3 (15.8%) episodes of FFP transfusion were deemed inappropriate. In the present study, the most common inappropriate usage was observed in patients with sepsis, accounting for 75%. Among these three patients, coagulogram was not performed in two, while one patient showed Prothrombin Time (PT) and Partial Thromboplastin Time (PTT) levels less than 1.5 times the normal range, with an International Normalized Ratio (INR) of 0.93. In a study conducted by Iqbal H et al., the most common inappropriate uses included bleeding with no abnormal coagulation test following cardiopulmonary bypass, hypovolaemia, and hypoproteinaemia [20]. Luk C et al., observed in their study that 85 patients (53%) received FFP inappropriately for active bleeding or preparation for emergency surgery or invasive procedures, despite having an INR or a Partial Thromboplastin Time (PTT) ≤1.5 times the normal range [21]. This contrasts with studies conducted by Emektar E et al., and Patel VR et al., which stated the reasons for inappropriateness as no active bleeding or prophylaxis for surgery and elevated INR without bleeding, respectively [22,23]. In the present study, the percentage of inappropriate usage of FFP was found to be 15.8%. The percentage of inappropriate usage of FFP in the studies conducted by Pahuja S et al., Chng WJ et al., and Chaudhary R et al., was found to be 78.2%, 70.06%, and 70.43%, respectively [24-26]. In the present study, the most common indications for FFP transfusion were bleeding disorders (36.8%), sepsis (21%), Von Willebrand disease (2%), and dengue (2%). Other less common indications included disseminated intravascular coagulation (DIC), liver disease, myelodysplastic syndrome, and iron deficiency anaemia . Dzik WH suggested three assumptions for inappropriate FFP orders: 1) In the setting of a procedure, elevation of Prothrombin Time (PT/INR) will predict bleeding [27]; 2) Prolonged clotting time results will be corrected by preprocedure administration of FFP; 3) Fewer bleeding events due to prophylactic transfusion.

Limitation(s)

The present study was conducted in a single tertiary care centre, and not all blood components such as cryoprecipitate and intravenous immunoglobulins were included in the study. Therefore, the findings cannot be generalised.

CONCLUSION(S)

A restrictive transfusion strategy can be implemented to optimise the use of blood and blood components. Inappropriate transfusions in cases of anaemia can be reduced by lowering the transfusion trigger to a haemoglobin level of <10 gm/dL. Setting a threshold for platelet transfusion at a platelet count <10,000/mm^3 will significantly decrease the incidence of inappropriate platelet transfusion. Educational programs aimed at promoting the appropriate use of blood products should be continued in order to decrease the risk of inappropriate transfusions. Establishing requirements to meet established criteria can serve as an effective mechanism to improve transfusion practices.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Dec 22, 2022
- Manual Googling: May 09, 2023
- iThenticate Software: Jun 02, 2023 (14%)

ETYMOLOGY: Author Origin

EMENDATIONS: 9

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Dec 19, 2022**
Date of Peer Review: **Feb 04, 2023**
Date of Acceptance: **Jun 03, 2023**
Date of Publishing: **Oct 01, 2023**