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Original

Evaluation of Optimal Blood and Blood Component Consumption in Children with Cancer in MAHAK Hospital

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Abstract

Background: Blood transfusion is an essential supportive treatment for children with cancer, but inappropriate or excessive use of blood components may increase risks and resource utilization. This study aimed to evaluate blood and blood component consumption and transfusion-related complications in children with cancer at MAHAK Hospital.

Materials and Methods: This retrospective study included 830 children with cancer who were admitted to MAHAK Hospital. Data on demographic and clinical characteristics, blood component transfusions, transfusion thresholds, and transfusion-related reactions were collected and analyzed using descriptive statistics.

Results: Of the 830 patients, 513 (61.8%) had solid tumors and 317 (38.2%) had non-solid malignancies. PRBC transfusion was recorded for 830 patients, platelet transfusion for 830 patients, and plasma transfusion for 495 patients. Most patients received 1–5 units of PRBCs (64.3%) or platelets (53.3%), while 40.4% received no plasma and 49.6% received 1–5 units. The most frequently recorded transfusion reaction was febrile reaction with PRBCs (12.2%). Allergic reactions were recorded in 3.9% of patients receiving platelets and 1% receiving plasma. Overall, transfusion reactions were less frequently recorded with plasma than with PRBCs or platelets.

Conclusion: The observed pattern of blood component utilization provides a description of transfusion practice in children with cancer at a specialized pediatric hospital. These findings may help inform patient blood management and future evaluations of transfusion practice in this population.

Keywords:

Pediatric cancer
Anemia
Blood Transfusion
Platelet Transfusion
Thrombocytopenia

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1. INTRODUCTION

Globally, cancer is a major cause of death in children, and its prevalence is increasing over time (1). Cancer is the leading cause of mortality in developed countries and the second most common cause in the developing world (1, 2). Although cancer rarely occurs in children and adolescents under the age of 20, when it does, it gives rise to a range of medical and societal concerns (1, 3). Recent studies have shown that the worldwide incidence of childhood cancers increased by 10-13% over the last two decades. (1, 4).

Anemia is highly common in patients with cancer. Anemia can be seen in 30% to 90% of patients, depending on the definition of anemia and cancer type (5-8). Anemia is characterized by a decrease in hemoglobin (Hb) level, RBC count, or packed cells volume (5). Causes of anemia in these patients are often multifactorial; it may result from myelosuppression, tumor infiltration, chronic inflammation, hemolysis, blood loss, nutritional deficiency, or dysfunctional erythropoiesis (5, 9, 10), in addition to the consequences of chemotherapy and radiotherapy. Anemia can have a negative impact on patient survival and quality of life. Therefore, treatment of anemia is considered a significant aspect of cancer care (6, 11).

One of the most common therapies to treat anemia is Packed Red Blood Cells (PRBC) transfusion (12-14). Blood and blood components are widely used in oncology, particularly for cancer patients who develop anemia (15). In total, around 34% of the RBC supply are used for oncological and hematological patients (16). PRBC transfusion is the only option for the rapid increase in Hb and hematocrit levels, so in case that patient requires immediate correction of anemia, PRBCs transfusion is preferable (5). Further enhancements, including leukoreductions, irradiation, washing, and cytomegalovirus-negative PRBCs may be needed in some cases (17). The decision to transfusion should not be driven by the hemoglobin level only, and patient's clinical status should be considered as well (13). Mainly, there are two approaches to treating anemia in cancer patients with PRBCs transfusion: liberal and restrictive strategies (18-20). In the Liberal strategy, transfusion is considered when hemoglobin concentration is 9-10 g/dL or lower, and in restrictive strategy, transfusion is considered when hemoglobin concentration is below 7-8 g/dL (13, 21, 22). The American Association of Blood Banks (AABB) recommends transfusion at a hemoglobin concentration of 7 g/dL for hemodynamically stable children, 7-9 g/dL for those with cardiovascular disease, and higher hemoglobin concentrations for patients with acute coronary syndromes (21).

The indication for platelet transfusion is 100,000/µl or transfusion based on the patient's bleeding or critical condition (15, 23). Coagulopathies are the indications for the transfusion of fresh-frozen plasma (FFP), cryoprecipitate, and platelets (5). Whereas platelets, microparticles, and FFP may directly stimulate tumor growth and spread (7–9).

Reactions or adverse events due to RBC transfusion are uncommon and may occur in 1% to 3% of transfusions (24). The most common adverse event is febrile nonhemolytic transfusion reaction, which typically is due to human leukocyte antigen (HLA) antibodies in the recipient or an allergic reaction to plasma proteins. This was a two-year retrospective study that aimed to evaluate the optimal use of cellular and plasma products in pediatric cancer.

2. MATERIALS AND METHODS

2.1. Study design

In this two-year retrospective study, we aimed to evaluate blood and blood component consumption in children with malignancies who were referred to MAHAK Hospital between March 2017 and March 2019.

2.2. Data Collection

Demographic information (including gender, age, date of birth) and clinical data (type of cancer, date of diagnosis, hospitalization, the status of patients, secondary cancer and relapse and metastasis or death, treatment protocols, type of blood, number of blood transfusions, the threshold of hemoglobin and platelets, and adverse events) were collected from patients' clinical documents,

2.3. Inclusion and exclusion criteria

All patients under the age of 19 diagnosed with cancer and received blood and blood components were included. Patients with thalassemia were excluded from the study.

2.4. Statistical Analysis

The collected data were analyzed using using descriptive statistics in SPSS software version 23. A P-value less than 0.05 was considered statistically significant.

2.5. Patient and Public Involvement

Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

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3. RESULTS

3.1. Patient's demographic and clinical characteristics

According to the hospital's Health Information Management Unit, 910 patients received blood and blood components during the study period. Of these, 830 children were diagnosed with cancer, while the other 80 had other hematologic conditions. The transfusion recipients' demographic profile, including gender and age, is presented for each cancer type in **Table 1**. The number of male patients was slightly higher than that of females, with 444 (53.5%) cases, while 386 (46.5%) were female. According to the World Health Organization, children with non-solid tumors were classified into four-year age groups (≤1, 1-4, 5-9, 10-14, ≥15). Based on this classification, 314 (37.8%) of children were in the first age group. Based on cnacer type, patients were classified into two groups: solid tumors (CNS Tumors, Sarcoma, Retinoblastoma, Neuroblastoma, Renal tumor, Hepatoblastoma, Langerhans cell histiocytosis, Germ Cell tumor) and non-solid tumors (Leukemia and Lymphoma). They were then classified into 10 groups according to WHO, as listed in **Table 1**. Solid tumors shared the highest proportion with 513 (61.8%), and the most common type was leukemia (31%), followed by CNS tumor (23.4%), while the least common type was Germ Cell tumor (1%) (Shown in **Figure 1**).

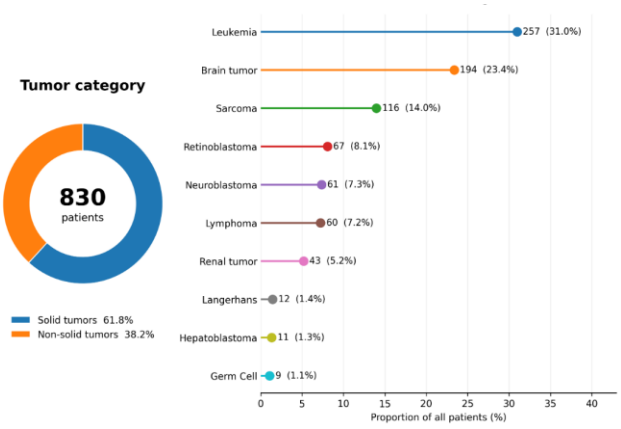


Figure 1. Malignancy profile of the study population.

Blood group A+ 198 (23.8%) and O+ 235 (28.3 %) were higher than the others, and A- 27 (3.2%) were the lowest. More information is given in **Table 2**.

To evaluate the survival of patients, they were classified into three groups: death, during treatment, and off treatment (finished treatment), with the highest number in the during treatment group, 324 (39.0%). A total of 203 (24.5%) patients experienced relapse. During the study, patients received different treatments based on their cancer types; however, some patients received a combination of two or three treatments, which are shown in full in **Table 2**. The most common type of treatment was chemotherapy 453 (54.6%).

3.2. Complications

Transfusion complications can be highly concerning, so it is important to check out whether recipients have shown any symptoms, what, and how severe their symptoms were (**Table 3**). About 80% of recipients have not reported any complications after receiving RBC. The most common complication was febrile reaction (101 patients (12.2%)). Allergic and hemolytic reactions were also reported. Complications following platelet transfusion in children with cancer were allergic and febrile reactions. Most of the cases (90.5%) showed no symptoms after receiving platelets, and the most common reaction was allergic reactions, reported in 32 patients (3.9%). Overall, complications following plasma transfusion were less frequent, with 95.4% of patients experiencing no complications, represented in **Figure 2**.

To evaluate blood and blood component consumption based on the type of cancer, patients were categorized into five-unit groups (0, 1-5 units, 6-10, 11-15, 16-20, 21-25, 26-30, 30-35, and more than 35 units). More than half of patients received less than 5 RBC units in this period (534 patients- 64.3%), and one patient received 53 units (the highest). Likewise, patients mostly received less than 5 platelet units (442 (53.3%)), and only 10% of patients received more than 5 plasma units. More information is given in **Table 4**.

4. DISCUSSION

4.1. Principal Findings

In this retrospective study, we evaluated the use of blood and blood components in children with malignancies at a single hospital over a two-year period. Our findings showed that many children with cancer required blood transfusions, with the majority receiving packed red blood cells (PRBCs). The most common type of cancer observed in our study was leukemia, followed by CNS tumors. Likewise, previous studies have shown that leukemia, CNS tumors, and lymphoma are the most common pediatric malignancies (25, 26).

In general, the incidence of childhood cancer is higher in males than in females (1, 25-27), and in this study the male-

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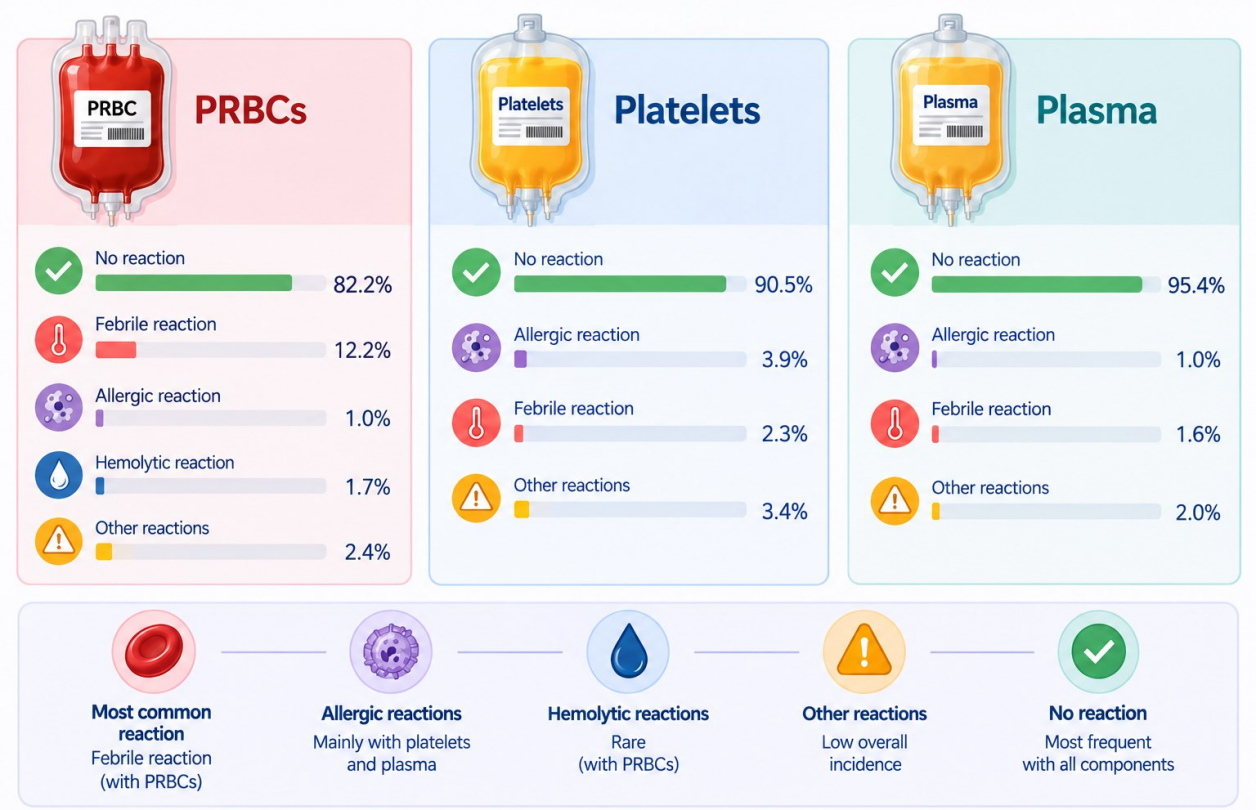


Figure 2. Transfusion reactions according to blood component. The distribution of transfusion reactions among pediatric patients receiving PRBCs, platelets, and plasma is shown. No reaction was the most frequent outcome for all components, while febrile reactions were the most common reaction following PRBC transfusion and allergic reactions were more frequent with platelets.

to-female ratio was 1.15:1. According to WHO reports and some other studies children are mostly in the 1–4-year age group; in this study, 39.8% of children fell into this category (26-28).

4.2. Strengths and Weaknesses of the Study

This study has several strengths, including the use of standardized transfusion thresholds and the exclusive use of leuko-reduced blood products, which are known to minimize complications. However, its retrospective nature, single-center design, and limited sample size may limit the detection of delayed transfusion reactions or long-term outcomes.

4.3. Comparison with Other Studies

In this study, a restrictive strategy was applied, and the indication for PRBC transfusion was hemoglobin threshold, and patients with Hb levels below 8 g/dl were transfused. The indication for platelet was a count below 10000/µl. For plasma transfusion, prolonged PTT or bleeding conditions in the patient were the criteria. However, under some circumstances such as infectious or neutropenic conditions, the American Association of Blood Banks (AABB), the European Society of Medical Oncology (ESMO), and some other studies recommend restrictive transfusion strategy for red blood cell transfusions in patients with cancer or other medical conditions(21, 22, 29-36). It is also recommended that the decision to transfuse should not solely be based on hemoglobin level or "trigger threshold", but rather on symptoms of anemia and the presence of comorbidities(37, 38). Some studies have shown that restrictive transfusion reduces mortality, morbidity, and complications in various patient populations(39), while others showed that there is no significant difference between these two strategies concerning survival (24). The use of leuko-reduced blood may also help reduce transfusion-related morbidities(37).

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Table 1. The sex and age group of patients based on the type of malignancy.

Type of cancer	No	Sex		Age group				
		Male	Female	<1	1-4	5-9	10-14	>15
Leukemia	257 (31)	154	103	26	108	58	51	14
Brain tumor	194 (23.4)	104	90	13	71	74	28	8
Sarcoma	116 (14)	54	62	4	31	38	35	8
Retinoblastoma	67 (8.1)	39	28	37	22	3	1	4
Neuroblastoma	61 (7.3)	22	39	8	37	9	3	4
lymphoma	60 (7.2)	33	27	0	11	24	21	4
Renal tumor	43 (5.2)	23	20	8	17	9	5	4
Hepatoblastoma	11 (1.3)	7	4	1	7	2	0	1
Langerhans	12 (1.4)	5	7	1	6	1	2	2
Germ Cell	9 (1.1)	3	6	0	4	3	2	0
Total	830	444	386	98	314	221	148	49

Table 2. Blood group, treatment protocol, and patient status in patients.

	No	%		No	%
Blood Group			**Treatment protocol**		
A+	198	23.8	CHE*	453	54.6%
A-	27	3.2	CHE+ RAD**	155	18.7%
B+	161	19.4	CHE+ SUR***	96	11.5%
B-	54	6.5	CHE+ RAD+ SUR	56	6.7%
AB+	66	8	Transplant+ CHE	13	1.6%
AB-	23	2.8	Transplant	10	1.2%
O+	235	28.3	RAD	6	0.7%
O-	66	8	Consultation	6	0.7%
Status			Transplant+ RAD	3	0.4%
Death	222	26.7	RAD+ SUR	14	1.7%
During treatment	324	39	SUR	18	2.2%
Off Treatment	284	34.2			
Relapse	203	24.5			
Metastasis	28	3.4			

* CHE: Chemotherapy
** RAD: Radiotherapy
*** SUR: Surgery

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Table 3. Transfusion complications of components in patients based on the type of malignancy.

Type of cancer	PRBC side effects					Platelet				Plasma side effects			
	Neg	Allergic	Febrile	Hemolytic	Other	Neg	Allergic	Febrile	Other	Neg	Allergic	Febrile	Other
Brain tumor	156	0	35	3	0	177	3	3	11	107	0	4	0
Germ Cell	7	0	1	0	1	8	0	1	0	6	0	0	0
Hepatoblastoma	7	0	4	0	0	9	0	1	1	5	0	0	1
Langerhans	9	0	3	0	0	9	3	0	0	6	0	0	1
Leukemia	200	1	37	5	14	229	19	3	6	150	4	0	6
lymphoma	53	4	3	0	0	53	3	4	0	36	1	0	0
Neuroblastoma	57	0	4	0	0	58	0	3	0	35	0	1	0
Renal tumor	38	0	2	0	3	42	0	1	0	25	0	1	0
Retinoblastoma	63	0	3	1	0	66	0	0	1	40	0	0	0
Sarcoma	97	3	9	5	2	100	4	3	9	62	0	2	2
Total	687	8	101	14	20	751	32	19	28	472	5	8	10
%	82.2	1	12.2	1.7	2.4	90.5	3.9	2.3	3.4	95.4	1	1.6	2

4.4. Meaning of the Study and Implications

Patient blood management (PBM) ensures optimal patient outcomes and manages the blood supply, guaranteeing that blood components are available when needed (21, 40). Using a PBM approach often results in fewer blood transfusions for patients, minimizing their risk of transfusion-related complications (41). Practicing liberal strategy leads to a reduction in RBC usage as well, and with no difference or even reduction in mortality (42), fits better within the PBM program; therefore, an Hb threshold below 8 g/dL, as applied in this study, appears optimal for transfusion. However lower Hb level may adversely affect patient well-being.

In the present study, all patients received leukoreduced products. Leukoreduced leukocyte products, which nowadays are being used to reduce leukocytes in cellular products (RBC, platelet), reduce the risk of blood transfusion complications (especially FNHTR) and alloimmune refractoriness to platelet products. It has also been shown that they decrease the risk of blood-borne viral infections (especially CMV) in cancer patients undergoing chemotherapy(43-45). We showed that complications followed by RBC transfusion happened in 17.8/% of patients, febrile reaction was higher (12.2%), while allergic reactions (1%) were lower. As these patients mostly experience pancytopenia due to chemotherapy treatment, febrile reactions are a common feature, and it is not distinguishable from transfusion febrile reactions. Allergic and febrile reactions have also been reported at 1-3% and 0.5-6% respectively (46). In the case of complications following platelet transfusion, allergic and febrile reactions were seen in 3.9% and 2.3%, respectively, while febrile reactions were reported in a wide range of cases (1-38%) (46, 47). Following plasma transfusion, complications occurred in 4.6% of patients including allergic, febrile reactions, Prescott has also reported a similar percentage (48).

5. CONCLUSIONS

In this single-center retrospective study, blood transfusion practices in children with cancer were generally consistent with a restrictive transfusion strategy and the principles of patient blood management. These findings may provide useful information regarding blood component utilization in pediatric oncology; however, further prospective studies are needed to evaluate the appropriateness of transfusion practices and optimize blood component use in this population. **Figure 3** summarizes the result of the study.

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Table 4. Consumption of components based on the type of cancer patients in five-unit groups.

Type of cancer	Consumption	0	1-5	6-10	11-15	16-20	21-25	26-30	31-35	≥35
Brain tumor	PRBCs	0	129	39	13	3	4	1	2	3
	Platelet	0	115	44	28	3	3	1	0	
	Plasma	83	99	8	4	0	0	0	0	0
Germ Cell	PRBCs	0	6	1	2	0	0	0	0	
	Platelet	0	5	3	1	0	0	0	0	
	Plasma	3	5	0	1	0	0	0	0	0
Hepatoblastoma	PRBCs	0	9	1	0	0	0	0	0	1
	Platelet	0	9	1	0	0	0	1	0	
	Plasma	5	4	2	0	0	0	0	0	0
Langerhans	PRBCs	0	8	1	1	0	0	1	0	1
	Platelet	0	6	2	2	2	0	0	0	
	Plasma	5	5	2	0	0	0	0	0	0
Leukemia	PRBCs	0	168	38	16	18	6	2	4	5
	Platelet	0	148	43	52	8	1	3	2	
	Plasma	97	136	19	3	2	0	0	0	0
lymphoma	PRBCs	0	22	17	11	5	1	0	2	2
	Platelet	0	31	10	17	2	0	0	0	
	Plasma	23	30	5	2	0	0	0	0	0
Neuroblastoma	PRBCs	0	48	7	2	0	1	1	2	0
	Platelet	0	32	19	4	5	0	1	0	
	Plasma	25	29	7	0	0	0	0	0	0
Renal tumor	PRBCs	0	31	5	1	2	1	0	1	2
	Platelet	0	22	6	8	5	1	0	1	
	Plasma	17	22	1	3	0	0	0	0	0
Retinoblastoma	PRBCs	0	61	1	0	1	1	1	1	1
	Platelet	0	19	11	17	10	4	2	4	
	Plasma	27	33	5	2	0	0	0	0	0
Sarcoma	PRBCs	0	52	30	20	3	7	2	0	2
	Platelet	0	55	24	34	1	1	1	0	
	Plasma	50	49	13	2	2	0	0	0	0
Total	PRBCs	0	534	140	66	32	21	8	12	17
	Platelet	0	442	163	163	36	10	9	7	
	Plasma	335	412	62	17	4	0	0	0	0

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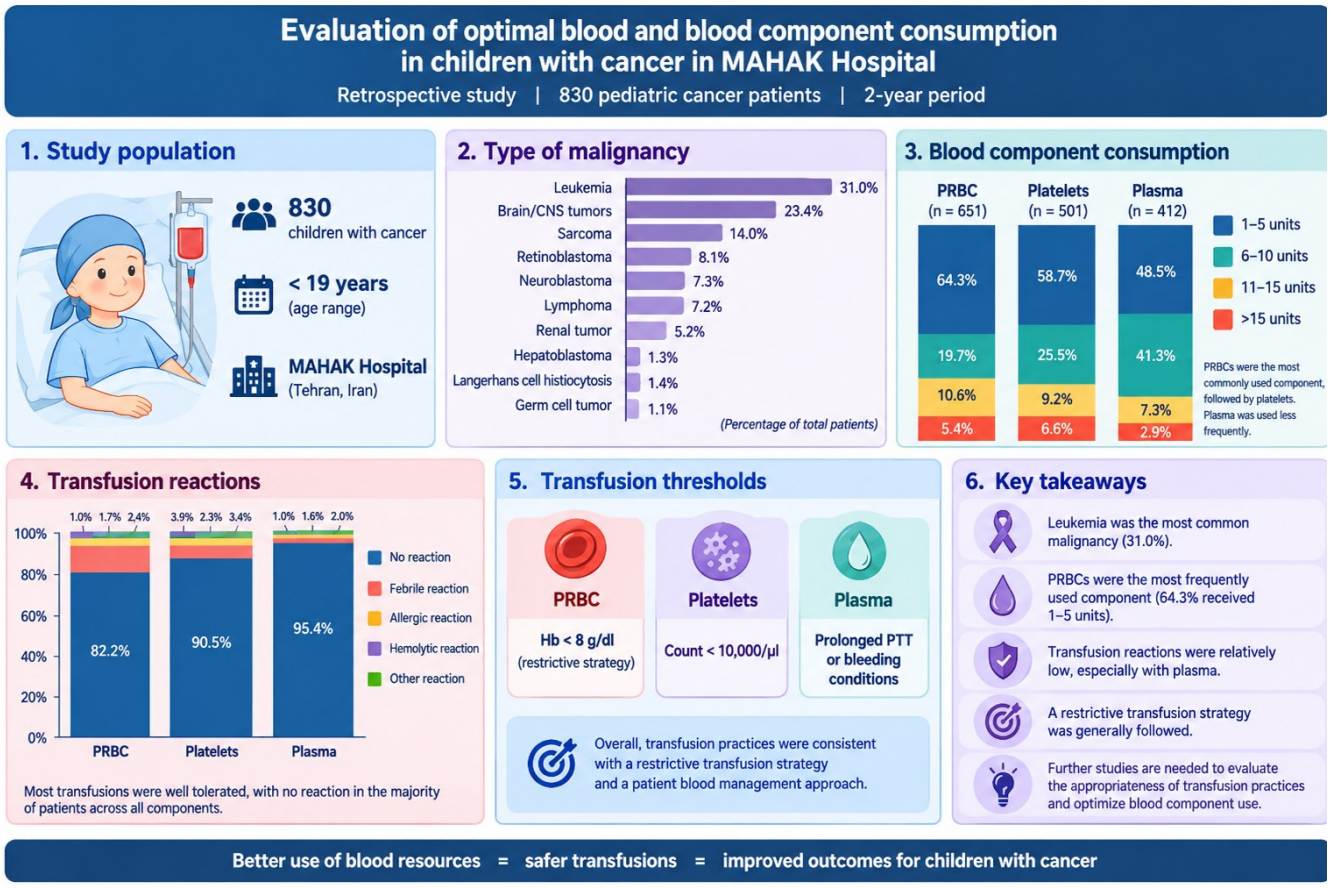


Figure 3. Graphical abstract of the study.

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Conflict of interest

All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/disclosure-of-interest/ and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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Ethical statement

The project was approved by the ethical standards of the High Institute for Research and Education in Transfusion Medicine (IR.TMI.REC.1398.002), with the 1964 Helsinki declaration and its later amendments. General consent was obtained from patients/guardians at hospital admission, permitting the use of anonymized clinical data for research purposes.

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