International Journal of Contemporary Pediatrics
Kambourou J et al. Int J Contemp Pediatr. 2025 Dec;12(12):1941-1946
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20253776

Original Research Article

Transfusion of red blood cell concentrates in children at Brazzaville University Hospital: epidemiological, clinical, and biological aspects

Judicaël Kambourou[1,2]*, Aymar Pierre Gildas Oko[1,2], Jevia Monica Mambou Pemba[2], Thibaut Ocko Gokaba Letsho[1,3], Léticia Lombet[2], Moyen-Engoba[1,2], Georges Marius Moyen[1,2]

[1]Department of Pediatrics, Faculty of Health Sciences, Marien NGOUABI University, Brazzaville, Republic of Congo
[2]Department of Pediatric Intensive Care Unit, Brazzaville University Hospital, Republic of Congo
[3]Department of Biological Hematology, Brazzaville University Hospital Laboratory, Republic of Congo

Received: 29 September 2025
Revised: 04 November 2025
Accepted: 14 November 2025

***Correspondence:**
Dr. Judicaël Kambourou,
E-mail: judyccokam@gmail.com

ABSTRACT

Background: Objective was to study the transfusion practice of red blood cell concentrates (RBC) in children hospitalized in the pediatric departments of the Brazzaville University Hospital.
Methods: A single-center analytical cross-sectional study on RBC transfusion in children was carried out between November 2022 and October 2023 in the pediatric departments of Brazzaville University Hospital Centre (B-UHC). Children aged 1 month to 17 years, hospitalized for severe anemia who had received a RGC transfusion were included. The study variables were sociodemographic, clinical, biological, those linked to blood transfusion (BT) of RBC and progressive. The Chi square test and odds ratio were used with significance at $p<0.05$.
Results: A total of 300 patients (21.59%) were included, including 53% boys, sex ratio 1.13. The average age was 21.5 months (range 1 month and 17 years). Children aged 1 month to 5 years represented 49.3%. Sickle cell disease was the main cause of anemia: 57.6%. The average haemoglobin (Hb) level before transfusion was 5.9 g/dl. The most used blood was that of group O+. TS significantly improved Hb and hematocrit levels. Death occurred in 17% of cases linked to low socio-economic status (SES), a long time to transfusion and a Hb level <5 g/dl on admission.
Conclusions: TS of RGCs remains a very frequent activity in the pediatric environment of the Brazzaville University Hospital in relation to the prevalence of severe anemia. The prevention of the main pathologies causing severe anemia as well as the strengthening of the capacities of the National Blood Transfusion Centre (NBTC) remain the essential therapeutic weapons.

Keywords: Transfusion, Red blood cell concentrates, Children, UHC, Brazzaville

INTRODUCTION

Blood transfusion (BT) involves replacing blood or one of cellular or plasma components from a donor with that of a recipient.[1] It is a procedure that is currently well codified and complies with regularly updated recommendations.[2] It is a life-saving procedure that significantly reduces morbidity and mortality associated with severe anemia. It must be performed in accordance with a number of steps to ensure its effectiveness and safety: indication, prescription of blood products, pre-transfusion testing, delivery of blood products, and the transfusion itself. Blood transfusion is a common practice in pediatrics. The World Health Organization (WHO) estimates that approximately two billion people worldwide suffer from anemia, with Africa bearing the heaviest burden, accounting for 60% of global blood needs.[3]

In sub-Saharan Africa, where diseases that cause severe anemia are prevalent, such as infectious diseases including

malaria, severe malnutrition, and sickle cell disease, these needs are just as significant. A study conducted in 11 French-speaking African countries involving children aged six months to five years reported that 4.9% of severe cases of anemia required a blood transfusion.[4] In Senegal, transfusions are given to 8% of hospitalized children.[5] Blood needs are even higher in Kenya and Gabon: 15.9% and 17.1% respectively.[6,7]

The Congo, a developing country with middle income, is no exception to this rule, as hospital statistics report a prevalence of 17.9% of pediatric transfusion activity at the Brazzaville University Hospital.[8]

Red blood cell concentrates (RBC) are labile blood products. Their transfusion aims to improve tissue oxygenation by compensating for a deficiency in the oxygen carrier, hemoglobin (Hb), and/or by reducing endogenous Hb production.[9] The procedure for evaluating transfusion efficacy is therefore the disappearance of clinical signs of poor tolerance of anemia and the regulation of the patient's hematological or biological parameters (Hb level and hematocrit percentage).[10]

However, blood transfusion (BT) is not without adverse effects; it carries the risk of immediate or delayed immunological complications, metabolic and circulatory complications, and transmission of infections.

The aim of this study was to examine the transfusion practices of RBC in children hospitalized in the pediatric wards of the Brazzaville University Hospital Center (CHU).

METHODS

This was a cross-sectional analytical study with prospective data collection conducted from 02 November 2022, to 31 October 2023, in the pediatric departments of the Brazzaville University Hospital, Republic of Congo: pediatric intensive care, pediatric care for older children, and pediatric care for infants. It involved children aged 1 month to 17 years hospitalized in the above-mentioned pediatric departments during the study period whose diagnosis included anemia requiring a red blood cell concentrate (RBC) transfusion.

All children included in the study underwent a complete blood count prior to RBC transfusion to determine their baseline hemoglobin level. The following were excluded from the study: patients who received emergency transfusions without knowing their hemoglobin level, those who received transfusions outside the pediatric departments selected for the study, and those who received a labile blood product other than packed red blood cells (PRBCs).

Written informed consent from the parent/legal guardian was required before enrolling the patient. Patients were recruited exhaustively and consecutively as they were admitted. Schwartz's formula enabled the sample size to be calculated.

$$N = P(1-P)\frac{Z_{\alpha}^{2}}{i^{2}}$$

Here, P is the prevalence, I is the margin of error or precision, and Zα is the margin coefficient derived from the confidence level. For a 95% confidence interval and a margin of error of 5%, Zα was set at 1.96. The prevalence P used in this study was 17.9%, based on the study of pediatric transfusion activity at the Brazzaville University Hospital.[8]

After calculation, the minimum sample size was estimated at 226 cases, but for representativeness purposes, we enrolled up to 300 patients.

The data are collected from the children's medical records and follow-up notebooks and then recorded on a pre-established survey form completed by the investigator.

The variables studied were: parents' sociodemographic parameters: gender, age, education level, occupation, marital status, socioeconomic status, those related to the child - sociodemographic parameters: age, gender, schooling, place of residence, personal history: previous RBC transfusions (number of transfusions and units transfused per transfusion), chronic conditions (sickle cell disease, heart disease, malignant blood disorders, and others), clinical: consciousness, general condition, color (pallor) of mucous membranes and skin, vital signs, heart rate (normal or tachycardia), respiratory rate (normal or tachypnea), blood pressure (normal or hypotension), pulse, temperature of the extremities, skin recoloration time (SRT), pulse oxygen saturation (SpO_2), cardiovascular and respiratory physical examination, biological: hemoglobin level, hematocrit percentage, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), platelet and white blood cell or leukocyte counts, Rhesus blood type (RBT), thick film blood smear test (BFST), irregular agglutinin test (IAT), variables related to RBC transfusion: indication, transfusion time, transfused volume (in ml), blood group of the bag (isogroup isoresus bag), transfusion incidents (during and after transfusion), and outcome after RBC transfusion: hemoglobin level and hematocrit percentage 24 hours after transfusion, incidents and accidents, death.

The data were analyzed using statistical package for the social sciences (SPSS) 25 software. Quantitative variables were expressed as means with standard deviations and/or medians with first and third quartiles. Qualitative variables were expressed as tables of absolute and relative frequencies.

To identify factors associated with transfusion effectiveness, a univariate analysis was performed. The dependent variable was cross-referenced with each of the independent variables.

In order to determine the strength of associations between the dependent variable and each independent variable, crude odds ratios were expressed with their 95% confidence intervals.

Statistical tests used for analysis

Pearson's Chi-square test was used to compare proportions, and Fisher's exact test was used when at least one theoretical frequency was less than 5.

The significance threshold for all statistical tests was set at 0.05.

RESULTS

Descriptive study

The selection flowchart is shown in Figure 1.

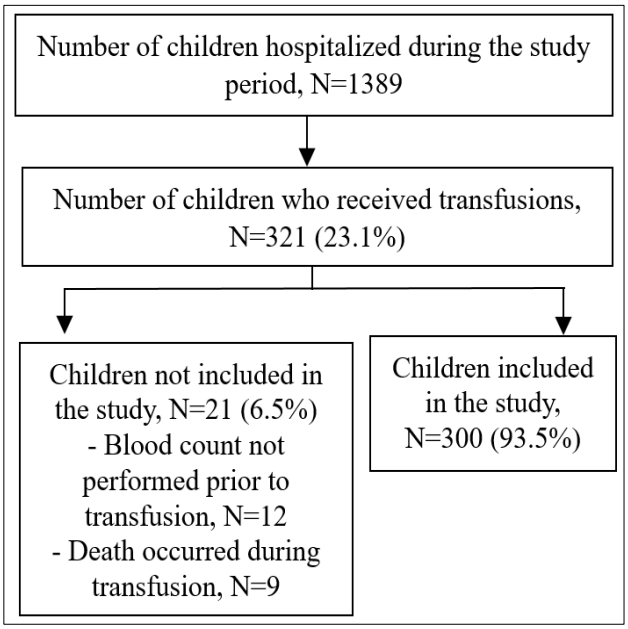

Figure 1: Selection flow chart.

Sociodemographic characteristics

During the study period, 300 children were included. Their average age was 4.2±0.3 years (range 1 month to 17 years). Children aged 1 month to 5 years accounted for 50.7% of cases. There were 159 (53%) boys and 141 (47%) girls, with a sex ratio of 1.13 (Table 1).

Table 1: Sociodemographic characteristics of the study population.

Variables	N	%
Age		
1 month-5 years	152	50.7
6-11 years	83	27.6
12-17 years	65	21.7
Sex		
Male	159	53
Female	141	47
Schooling		
Yes	128	42.6
No	47	15.6
Average age of mothers	26.4±1.1 years (extremes 15 and 43 years)	
Mother's level of education		
Primary	50	16.7
Secondary	179	59.7
Higher education	45	15
No formal education	21	8.6
Mothers' profession		
Formal sector	53	17.7
Informal sector	221	73.7
Unemployed	26	8.6
Household socioeconomic level		
Low	206	68.7
Medium	92	30.7
High	2	0.6

Medical history and previous transfusions

Among the children included in the study, 142 (47.3%) had previously experienced an episode of severe anemia, and 138 (46%) had received red blood cell concentrates. This involved multiple transfusions (more than three transfusions) in 46 (15.3%) cases. In 116 (38.7%) cases, they were living with homozygous sickle cell disease. The labile blood products previously transfused were RBCC in 138 cases and platelet concentrates in five cases.

Clinical aspects of children receiving transfusions

All children included in the study presented with skin and mucosal pallor. The signs associated with this were: hypodynamia in 259 (86.3%) cases, fever in 225 (75%) cases, impaired consciousness in 48 (16%) cases, and cold extremities in 156 (52%) cases.

The conditions responsible for the hospitalization of children during the study period are shown in Figure 2.

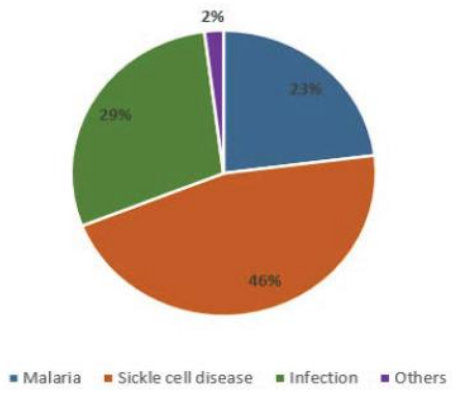

Figure 2: Conditions requiring hospitalization.

Biological aspects

The average hemoglobin level before transfusion of red blood cell concentrates was 5.9±0.4 g/dl (range 1.8 to 10.5 g/dl). The average hematocrit value was 18.5%±0.8 (range 12.6% to 39%); the mean corpuscular volume of the children was 80.19±3.2 fl (range 54 to 118 fl). Blood group O Rh positive (O+) was found in 143 children (47.6%).

Therapeutic aspects and transfusion incidents

The average time taken to obtain blood after the doctor's prescription was 3.3±1.1 hours, with extremes of 15 minutes and 48 hours. The average volume of red blood cell concentrates transfused was 286.6±15 ml. The duration of transfusion was less than 4 hours in 11 (3.7%) cases, 4 hours in 284 (94.7%) cases, and more than 4 hours in 5 cases (1.6%).

The transfusion of RBCs was isogroup and isoresus in 286 (95.3%) cases; in 14 (4.7%) cases, O-negative RBC concentrate was transfused to children of other groups due to the unavailability of blood from their own group. The blood bags used were 450 ml in all cases; blood loss averaged 21±0.7 ml/kg of body weight. Transfusion reactions were noted in 21 (7%) patients. These included shivering-hyperthermia syndrome (10 cases), volume overload (7 cases), and urticaria in 4 cases.

Progressive aspects

Twenty-four hours after transfusion, the mean hemoglobin level was 9.22±0.6 g/dl (range 8 to 16 g/dl) versus 5.9±0.4 g/dl (range 1.8 g to 10.5 g/dl) before transfusion; the hematocrit level was 26.9±11.3% (range 17.3 and 64.5%) versus 18.5±0.8% (range 12.6% and 39%) before transfusion. One death was noted among 51 (17%) children who received transfusions.

Analytical study

The factors associated with death in transfused children identified in our logistic regression analysis are listed in Table 2.

Table 2: Factors associated with death.

Variables	ORa	IC 95%	P value
Socioeconomic status			
Medium/high	Ref	-	-
Low	2.38	[1.11-5.10]	0.0246
Transfusion delay (hours)			
≤4	Ref	-	-
>4	2.42	[1.08-5.42]	0.0303
Hemoglobin on admission (g/dl)			
>5	Ref	-	-
≤5	2.06	[1.08-3.90]	0.0261
Origin			
Home	Ref	-	-
University Hospital Services	2.33	[0.98-5.53]	0.0531
Other entities	1.52	[0.66-3.46]	0.3169

DISCUSSION

To carry out this study, 300 children who had received transfusions were selected, representing a prevalence of 21.6% of all children hospitalized during the study period. Transfusion activity remains frequent in Congolese pediatric settings, as evidenced by the work of Okoko and Lepfoundzou.[8,11] Diakité in Mali and Diouf in Dakar reported lower proportions: 7.9% and 11.8% respectively, undoubtedly due to methodological differences.[1,12] Most children receiving transfusions in Brazzaville (49.3%) are between 1 month and 5 years old, which is consistent with the findings of Okoko, Simaga, Al-Saqladi, and Mayuku.[2,8,10,13] According to the World Health Organization (WHO), 65% of transfusions in low-income countries involve children aged 1 to 5 years old due to their high vulnerability to anemia-causing conditions such as severe malaria, severe malnutrition, and invasive bacterial infections. Many of the children included in this study (45%), as in Mayuku's study, had a history of blood transfusions, including multiple transfusions.[10] The high prevalence of hemoglobin S in these countries explains the frequency of blood transfusions in these children, since severe acute anemia is one of the main acute complications of the disease.

In this study, the main causes of anemia were homozygous sickle cell disease (57.6%), septic conditions (36.3%), and malaria (29.3%), whereas for Simaga, Okoko, Diouf, Mayuku, and Bobossi, malaria-related anemia was the most common indication for transfusion. Al-Saqladi found septic conditions to be the predominant cause of anemia requiring blood transfusion, with sickle cell disease accounting for only 14.3% of cases.[1,2,8,10,13,14]

The most commonly used blood type is O positive (O+), which accurately reflects the distribution of blood types worldwide. The blood bags used in this study are 450 ml due to a lack of pediatric preparations, resulting in significant blood loss estimated at approximately 21 ml/kg. The blood used is only compatible in 95.3% of

cases instead of 100%, highlighting the difficulties of blood supply and distribution at the national blood transfusion center (NBTC). The low rate of blood donation in low-income countries, estimated by the WHO at only 16.4 donations per 1,000 inhabitants in these countries, reflects this difficulty.[15]

Transfusion of red blood cell concentrates significantly increases hemoglobin levels and hematocrit percentages. The work of Mayuku and Diakité confirms these results.[10,12] However, this increase did not differ significantly between different pathologies. The correction of anemia would therefore appear to be independent of its underlying mechanism. The transfusion of red blood cell concentrates is a factor in reducing morbidity and mortality associated with severe anemia, as evidenced by the 83% favorable outcome rate observed in this study. The effectiveness of transfusion therapy is a proven fact, as demonstrated by several African authors.[1,2] The occurrence of death observed in 17% of cases in this study is related to the socioeconomic status of the parents' households, the time elapsed between the indication and the transfusion >4 hours; and the hemoglobin value <5 g/dl on admission ($p<0.05$). These factors have already been reported by Abysina Soda, Soumaya, and Simaga.[2,16] According to Abysina Soda, a low economic well-being index for households is a risk factor for the occurrence of anemia in children in the Democratic Republic of Congo and therefore a poor prognosis.

Limitations

This study on red blood cell transfusions in children at the Brazzaville University Hospital undoubtedly had some limitations.

The first relates to the data source, as some parents or adolescents did not have health records. When records were available, several data points were missing or incomplete, making the collected data self-reported.

The second relates to the study setting; we did not include children followed in specialized centers such as the National Reference Center for Sickle Cell Disease, which has a high transfusion activity. This may constitute a recruitment bias.

Finally, the cross-sectional nature of the study provides only a snapshot in time. A longitudinal study would be appropriate and preferable for monitoring transfused children.

CONCLUSION

The transfusion of RBCCs remains a very common procedure in the pediatric ward of the Brazzaville University Hospital. The main conditions causing severe anemia and therefore requiring blood transfusions in Brazzaville are sickle cell disease, septic conditions, and malaria. Children under the age of 5 with a history of TS are the most vulnerable. The blood used is only 95.3% compatible. The high mortality rate among transfused children is related to low socioeconomic status, excessive delay between indication and transfusion, and hemoglobin levels <5 g/dl on admission.

ACKNOWLEDGEMENTS

Authors would like to thank all the staff of the pediatric departments at Brazzaville University Hospital for their cooperation. They would also like to thank the management of Brazzaville University Hospital for authorizing this research.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Diouf JB, Sougou NM, Kane M, Sylla A, Ndiaye O. Blood Transfusion in children in Guédiawaye. Médecine d'Afrique Noire. 2018;6506:339-49.
2. Oumar S. Transfusion activity in the pediatric department of the hospital in Mali. General medicine practice theses. University of Sciences, Techniques and Technologies of Bamako. 2021. Available at: https://www.bibliosante.ml/handle/123456789/5196 . Accessed on 12 September 2025.
3. World Health Organization (WHO). Universal Access to Safe Blood Transfusion. Department of Essential Health Technologies. Blood Transfusion Safety Unit. 2008;19. Available at: https://www.who.int/publications/i/item/WHO-EHT-08.03. Accessed on 12 September 2025.
4. Diouf S, Floquet M, Mbofung K, Ndiaye O, Brou K, Dupont C, et al. Prevalence and determinants of anemia in young children in French-speaking Africa. Role of iron deficiency. Arch Pediatr. 2015;22(11):1188-97.
5. Ndiaye MM. Pratique de la transfusion érythrocytaire au centre hospitalier Albert Royer. Thèse N°130 Pour l'obtention du grade de Docteur en Médecine (Diplôme D'Etat). Faculté de Médecine, de Pharmacie et d'odonto-stomatologie. Université Cheik Anta DIOP de Dakar. République du Sénégal. 2008.
6. Nabwera HM, Fegan G, Shavadia J, Denje D, Mandaliya K, Bates I, et al. Pediatric blood transfusion practices at a regional referral hospital in Kenya. Transfusion. 2016;56:2732-8.
7. Mimbila MM, Minto'o RS, Mintsa MNE, Kuissi KE, Bisvigou U, Koko J, et al. Indication and Outcomes of Paediatric Blood Transfusion at Three Hospitals in Gabon, Africa. Africa Sanguine. 2020;22:10-3.
8. Okoko A, Galiba F, Moyen-Engoba, Oko A, Moyen G. activité transfusionnelle pédiatrique au CHU de Brazzaville, Sciences et Médecine, Rev. CAMES, Série A. 2008;6:30-3.

9. Djoudi R. Principes et spécificités Transfusion de l'utilisation des produits sanguins labiles chez l'enfant (à l'exclusion de la période néonatale). Hématologie. 2010;16:382-8.
10. Gustave MF, Hyppolite S, Ferdinand MK, Donatien KN, Desire MK. Evaluation de l'efficacité de la transfusion sanguine chez l'enfant à Kinshasa: expérience de trois formations médicales. Transfusion Clinique et Biologique. 2013;20:1-8.
11. Lepfoundzou Dzia A, Angounda BM, Niama FR, Gambicky R, Oko APG, Okoko AR, et al. Suivi Sérologique d'une Cohorte d'Enfants Transfusés au CHU de Brazzaville, Congo. Health Sci Dis. 2017;18:39-43.
12. Diakité AA, Konaté I, Sacko K, Diakité FL, Harber B, Traoré NL, et al. Causes infectieuses des anémies au CHU Gabriel Touré à Bamako au Mali. Revue malienne d'infectiologie et mibrobiologie. 2015;15:42-9.
13. Al-Saqladi AW M, Albanna TA. A Study of Blood Transfusion in Pediatric Patients at a Teaching Hospital, Aden, Yemen. Int J Clin Transfus Med. 2021;l9:1-9.
14. Salmon C, Julien AM. La transfusion sanguine homologue. In: Albert Najman, Elisabeth Verdy, Gérard Potron, Françoise Isnard Grivaux. Précis des maladies du sang. Tome II. Paris: Ellipses. 1994;626.
15. World Health Organization. Transfusion safety and blood supply. Available at: https://www.who.int/fr/news-room/fact-sheets/detail/blood-safety-and-availability. Accessed on 12 September 2025.
16. Abysina Soda M, Ngianga-Bakwin K, Kabali Hamuli E. Facteurs de risque de l'anémie des enfants en RDC: Approche de Régression logistique ordinale du Modèle du Poids d'échantillonnage des données complexes de l'EDS-RDC II. BHS. 2021;2:28-47.

Cite this article as: Kambourou J, Oko APG, Pemba JMM, Letsho TOG, Lombet L, Engoba M, et al. Transfusion of red blood cell concentrates in children at Brazzaville University Hospital: epidemiological, clinical, and biological aspects. Int J Contemp Pediatr 2025;12:1941-6.