Optimizing Neonatal Healthcare: A Comprehensive Study on Blood Transfusion Practices and Outcomes

David Nzambimana [1], Dionys Nsanzabagenzi [2, 3], Liboire Barenzako [4], Prosper Ndayisenga [5], Antoine Marie Vyamungu [1], Epipode Ntawuyamara [6*]

[1] School of Health Management, Southern Medical University, Guangzhou, China
[2] Department of Nephrology, Zhujiang Hospital, Southern Medical University, Guangzhou, China
[3] Department of Nephrology, Kamenge Military Hospital, Bujumbura, Burundi
[4] Department of Emergency, Kamenge Teaching Hospital of University of Burundi, P. Box 1020, Bujumbura, Burundi.
[5] Department of Pediatrics, Kamenge Military Hospital, Bujumbura, Burundi
[6] Department of Dermatology and Venereology, Faculty of Medicine, Kamenge Teaching Hospital of University of Burundi, P. Box 1020, Bujumbura, Burundi.

*** Corresponding Author: Epipode Ntawuyamara,** Department of Dermatology and Venereology, Faculty of Medicine, Kamenge Teaching Hospital of University of Burundi, P. Box 1020, Bujumbura, Burundi

David Nzambimana, Dionys Nsanzabagenzi, and Liboire Barenzako contributed equally to this study.

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Abstract

Introduction: Blood transfusion is a critical intervention in neonatal care, particularly for premature infants, to address complications such as anemia of prematurity and hemorrhagic shock. This study aimed to evaluate blood transfusion practices and outcomes in neonates at Kamenge Teaching Hospital, Burundi, addressing a gap in the literature specific to this region.

Materials and Methods: A prospective, observational study was conducted from January to August 2024, including 48 newborns who met the eligibility criteria and underwent blood transfusion. Data were collected using pre-established forms and analyzed using Microsoft Word 2010 for text entry, and Excel 2010 and SPSS version 25 for data analysis and processing. The study was approved by the Ethics Committee of Kamenge Teaching Hospital, and informed consent was obtained from the parents or legal guardians of each participant.

Results: The study found a higher proportion of female newborns (54.2%) and those from rural areas (64.6%). Prematurity was the leading cause for hospitalization (42.7%), and the majority had moderate anemia (62.5%). The majority of transfusions were well-tolerated, with a low incidence of transfusion-related accidents (6.3%). Favorable clinical evolution was observed in 83.3% of cases, while the mortality rate was 16.7%.

Conclusion: The study underscores the critical need for optimizing blood transfusion practices and neonatal care in Burundi. Recommendations include reviewing transfusion protocols, strengthening management measures for preterm infants, expanding preventive health measures in rural areas, and investing in the training and education of healthcare providers. The study also highlights the importance of ongoing monitoring and further research to improve neonatal health outcomes in low-resource settings.

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1. Introduction

Neonatal healthcare is a critical field that requires meticulous attention and advanced medical practices to ensure the survival and well-being of newborns, particularly those born prematurely or with underlying health conditions. Among the various medical interventions, blood transfusion stands out as a life-saving procedure that plays a pivotal role in the management of neonatal complications such as anemia of prematurity, hemorrhagic shock, and other hematological disorders [1-3]. Despite its significance, the practice of blood transfusion in neonates is complex and must be carefully managed to minimize risks and

maximize benefits. In recent years, there has been a growing recognition of the unique physiological and immunological characteristics of neonates, which necessitate specific transfusion protocols. Unlike older children and adults, neonates, especially those under three months of age, have a developing immune system and a higher vulnerability to transfusion-related complications [4, 5]. This has led to the evolution of transfusion medicine, with a particular focus on enhancing safety protocols and reducing the exposure to multiple donors, thereby minimizing the risk of infections and immunization reactions.

Blood transfusion is particularly indicated for the acute management of perinatal or surgical hemorrhagic shock and for the recurrent correction of anemia of prematurity [6]. The landscape of blood transfusion practices has been significantly influenced by the HIV/AIDS epidemic, which has heightened awareness of the risks associated with multiple blood donors [7, 8]. Advances in transfusion medicine have led to the implementation of single-donor protocols, where multiple pediatric units are derived from a single donation. This approach not only reduces the risk of exposure to potential infections but also minimizes the immunological risks associated with multiple donors [9, 10].

Moreover, blood transfusion in neonates is often part of a multi-modal therapeutic approach, frequently combined with other interventions such as intensive phototherapy for the management of hyperbilirubinemia, a common condition in this population [11, 12]. The effective management of hemolytic diseases in newborns, which often require repeated transfusions during the early weeks of life, is a testament to the importance of a comprehensive and integrated approach to neonatal healthcare.

Despite the critical role of blood transfusion in neonatal care, there is a notable lack of specific studies addressing transfusion practices and outcomes in neonatology departments in many regions, including Burundi. This gap in the literature is particularly concerning given the high prevalence of premature births and the associated complications in these areas [13]. The absence of robust data on transfusion practices and outcomes hinders the development of evidence-based protocols and the optimization of neonatal healthcare services.

The present study aimed to address this gap by conducting a comprehensive evaluation of blood transfusion practices and their outcomes at the Kamenge Teaching Hospital in Burundi. By investigating the demographics, clinical characteristics, and transfusion-related outcomes in this population, we hope to contribute valuable insights that can enhance neonatal health and inform future practices in the region. This study is not only a step towards improving the quality of care for neonates in Burundi but also an opportunity to contribute to the global dialogue on neonatal health, emphasizing the importance of context-specific approaches and the need for targeted interventions to optimize neonatal healthcare outcomes [14].

2. Materials and methods

2.1. Study setting and population

This prospective, observational study was conducted at the Kamenge Teaching Hospital in Bujumbura, Burundi, from January to August 2024. The objective was to investigate the practices and outcomes of blood transfusion in the neonatology department of the Kamenge Teaching Hospital, a national referral hospital located in the Northern Health District of Bujumbura. The study was focused on newborns who were hospitalized in the Neonatology department, which is a unit of Pediatrics, and received blood transfusion during the study period. All eligible newborns who met the inclusion criteria and were transfused within the study timeframe were included in the data collection.

2.2. Sample size justification

The study employed an exhaustive recruitment strategy, enrolling all eligible newborns who received blood transfusion during the specified period. In total, 48 newborns included provided a robust dataset for observing the transfusion practices and outcomes within our study's parameters.

To further strengthen the study, we performed a post-hoc power analysis to assess the adequacy of our sample size in detecting significant differences in transfusion practices and outcomes.

2.3. Collection tools and data sources

Data collection was facilitated by a pre-established survey form designed to capture variables across four main categories: epidemiological, clinical, para-clinical, and evolutionary. Information was gathered from multiple sources, including parental interviews, prescription sheets, medical records of newborns, transfusion logs, blood grouping registers, and the neonatology department 's entry and exit registers.

2.4. Data analysis

The software used for data management and analysis included Microsoft Word 2010 for text entry, and both Excel 2010 and SPSS version 25 for data analysis and processing. The results were tabulated and graphed to represent the data in a clear and interpretable format, with findings expressed as averages and percentages.

2.5. Ethical considerations

This research was carried out in accordance with the ethical guidelines of the Declaration of Helsinki and received approval from the Ethics Committee of Kamenge Teaching Hospital. Given the vulnerable nature of the study population—newborns who required blood transfusions—we obtained the informed consent from the parents or legal guardians of each participant. To protect the privacy and confidentiality of the study participants, all data collected were anonymized and de-identified. Personal identifiers were removed from the dataset.

3. Results

Table 1: Demographic and clinical characteristics of newborns receiving blood transfusion

Category	Subcategory	Frequency(n=48)	Percentage
1. Demographic characteristics			
Residence of the parents	Urban	17	35.4
	Rural	31	64.6
Sex	Male	22	45.8
	Female	26	54.2
Maternal age			
	<20 years	6	12.5
	20 to 30 years	28	58.3
	30 to 40 years	12	25
	>40 years	2	4.2
Parity			
	Parity=1	12	25
	Parity=2-3	21	43.8
	Parity≥4	15	31.2
Mean weeks (+/-SD)	28.6+/-6.09		
Term of pregnancy			
	Extremely preterm	3	6.3
	Very preterm	19	36.3
	Moderate preterm	7	14.6
	Late preterm	3	6.3
	Term	16	33.3
Mean weeks (+/-SD)	33.42weeks +/-4.57weeks		
Birth weight			
	<1500g	9	18.8
	[1500g-2500g]	24	50
	>2500g	15	31.2
Mean weight (+/-SD)	2051.04g +/-812.37g		
2. Clinical Characteristics			
Reasons of hospitalization			
	Convulsion	1	2.1
	Respiratory distress	4	8.3
	Respiratory distress, infection	1	2.1
	Respiratory distress, anal imperforation	1	2.1
	Hypotrophy, hyperglycemia	1	2.1
	Jaundice	1	2.1
	Jaundice, duodenal atresia	1	2.1
	Imperforate anus	1	2.1
	Infection, respiratory distress	2	4.2
	Infection, jaundice	2	4.2
	Prematurity	15	31.3
	Prematurity, duodenal atresia	1	2.1
	Prematurity, respiratory distress	12	25
	Prematurity, respiratory distress, jaundice	2	4.2
	Prematurity, infection	1	2.1
	Prematurity, infection, respiratory distress	1	2.1
	Infection, jaundice	1	2.1
Physical Signs			
	Pallor	36	20.8
	Tachypnea	24	13.9
	Tachycardia	15	8.7
	Fever	15	8.7
	Nasal flaring	15	8.7
	Xiphoid retraction	13	7.5
	Intercostal retractions	12	6.9
	Expiratory grunt	12	6.9
	Thoraco-abdominal asynchrony	9	5.2
	Neonatal jaundice	10	5.8
	Dyspnea	28	42.4
	Abdominal bloating	7	14.7
	Vomiting	5	10.6
Biological Characteristics			
Hemoglobin			
	<7 (Very Severe Anemia)	2	4.2

	[7-10[(Severe Anemia)	10	20.8
	[10-12[(Moderate Anemia)	30	62.5
	[12-13[(Low Anemia)	6	12.5
Average Hb	10.73+/-1.45g/dl		
Blood groups			
	A+	11	22.9
	AB+	1	2.1
	B+	7	14.6
	O-	2	4.2
	O+	27	56.3

Note: Blood groups: A plus (+) means Rh-positive blood and a minus (-) means Rh-negative blood. Rh factor, also known as the Rhesus factor (antigen D on the surface of red blood cells) is a critical component of blood type classification that affects blood transfusion compatibility

The study sample, drawn from 138 newborns hospitalized at Kamenge Teaching Hospital, included 48 (34.78%) newborns who received blood transfusions. Among these, there was a slightly higher proportion of females (54.2%) compared to males (45.8%). The maternal age distribution was heavily skewed towards younger mothers, with 58.3% aged between 20 and 30 years. In terms of parity, a significant portion of the newborns were from multiparous mothers, with 43.8% born to mothers with two to three previous deliveries, and 31.2% from mothers with four or more deliveries. The mean gestational age was 28.6 weeks, indicating a high prevalence of preterm births. The majority of newborns (66.7%) were premature, with extremely preterm and very preterm categories accounting for 39.6% and 36.3% of cases, respectively. The mean birth weight was 2051.04g, with 50% of newborns weighing between 1500g and 2500g at birth, indicating a significant number of low-birth-weight infants. Prematurity was the leading cause for hospitalization (42.7%), followed by respiratory distress (29.3%), which is consistent with high rate of prematurity as preterm infants often require respiratory support. The most common physical signs observed were pallor (20.8%) and polypnea (13.9%), indicative of anemia and respiratory distress, respectively. These signs align with the high rates of anemia and prematurity in the study population. Most transfused newborns had moderate anemia (62.5%), with severe anemia present in 20.8% of cases. The majority of newborns had blood type O+ (56.3%), followed by A+ (22.9%). The majority (95.8%) received packed red blood cells (PRBC), reflecting the standard practice of administering compatible blood products to minimize transfusion reactions.

Table 2: Transfusion practices and clinical outcomes in newborns

Category	Subcategory	Frequency(n=48)	Percentage
Indications			
	Hemorrhage	6	12.4
	Thrombocytopenia	5	10.4
	Anemia	4	97.9
Nature of products			
	PRBC and FFP	1	2.1
	Whole Blood	1	2.1
	PRBC	46	95.8
Number of transfusions			
	A single transfusion	32	66.7
	Two transfusions	10	20.8
	Three transfusions	5	10.4
	Four transfusions	1	2.1
Transfusion accidents			
	Apnea	1	2.1
	Jaundice	1	2.1
	Dyspnea	1	2.1
	Vomiting	3	6.3
Evolution			
Weight at discharge			
	<1500gr [	4	8.3
	[1500-2500gr [	30	62.5
	[2500-4000]	14	29.2
Average weight at discharge	2207.5g +/-698.72g		
Clinical evolution			
	Death	8	16.7
	Favorable	40	83.3

Abbreviation: PRBC, packed red blood cells; FFP, fresh frozen plasma

Anemia was the primary reason for blood transfusions, accounting for 97.9% of cases, with hemorrhage and thrombocytopenia less frequently cited at 12.4% and 10.4%, respectively. The predominant product used was packed red blood cells (PRBC), used in 95.8% of cases, suggesting a preference for this type of transfusion due to compatibility and safety. The predominance of normochromic anemia (68.7%) over hypochromic anemia (31.3%) suggests that

anemia in these newborns was more likely due to a decrease in red blood cell mass rather than deficiencies in hemoglobin production. This information is crucial for guiding treatment strategies, as it points towards the need for blood transfusions to address anemia rather than iron supplementation or other interventions to increase hemoglobin production.

Most newborns (66.7%) received only one transfusion, while a significant number required additional transfusions, indicating the severity of their conditions. The low incidence of transfusion-related accidents, with vomiting affecting 6.3% and other issues like dyspnea, apnea, and jaundice each affecting 2.1%, suggests that transfusions were generally well-tolerated.

Regarding weight, 62.5% of newborns had a discharge weight between 1500g and 2500g, with 29.2% weighing at least 2500g at discharge, indicating some positive weight gain during hospitalization. The average discharge weight was 2207.5g, with a considerable standard deviation, reflecting variability in weight gain.

Clinically, 83.3% of newborns showed favorable evolution after transfusion, but a concerning 16.7% mortality rate was observed, highlighting the challenges in managing critically ill newborns despite transfusion interventions.

4. Discussion

Our findings provide a valuable perspective on neonatal blood transfusion practices in Burundi, a region with healthcare challenges. To place our results within the broader context of global neonatal health, we compared them with those from similar studies conducted in diverse regions and settings.

The high prevalence of prematurity (66.7%) among transfused newborns in our study aligns with the increased vulnerability of preterm infants to anemia and other complications [13]. This rate is notably higher than that reported in some developed countries, where advanced neonatal care and better healthcare infrastructure reduce the incidence of severe prematurity-related complications. For instance, a study conducted in the United States by Patel *et al*. (2021) reported a lower rate of prematurity among transfused newborns, highlighting the impact of healthcare infrastructure on neonatal outcomes [13].

The proportion of newborns with moderate anemia (62.5%) in our study was consistent with findings from other low- and middle-income countries, where limited access to preventive measures and timely interventions contribute to a higher burden of anemia [4, 5]. However, it contrasts with reports from countries with comprehensive newborn screening and treatment programs, which have successfully reduced the prevalence of anemia in newborns [13]. This disparity underscores the need for improved preventive and therapeutic measures in resource-limited settings.

The low incidence of transfusion-related accidents (6.3%) in our study is encouraging and aligns with studies that emphasize the importance of strict transfusion protocols and the use of single-donor units to minimize risks [9, 12]. This finding underscores the effectiveness of current safety measures, even in resource-limited settings like ours. The implementation of single-donor protocols has been shown to reduce the risk of exposure to potential infections and immunization reactions, which is particularly important in neonates with developing immune systems [9, 10].

The significant mortality rate (16.7%) among newborns with congenital anomalies in our study is a stark reminder of the challenges faced in managing these complex cases. This rate is higher than that reported in some high-income countries with more advanced neonatal intensive care units and specialized surgical capabilities [14]. It underscores the need for improved diagnostic and treatment options for congenital anomalies in our setting. Early and accurate diagnosis, coupled with specialized care, can significantly improve outcomes for these newborns.

While our study's findings are consistent with those from other low- and middle-income countries, they also highlight the disparities in neonatal care when compared to more developed regions. These comparisons not only validate our results but also emphasize the need for targeted interventions to improve neonatal health outcomes in Burundi and similar settings. For example, the high prevalence of prematurity and anemia in our study population highlights the need for improved prenatal care, optimized delivery room practices, and enhanced neonatal surveillance [13]. In developed countries, comprehensive neonatal care and surveillance have been shown to significantly reduce the incidence of severe prematurity-related complications and improve long-term outcomes [15, 16].

Based on the findings of this study, several recommendations can be made to enhance clinical practice, particularly in the management of blood transfusions and overall neonatal care at Kamenge Teaching Hospital and similar settings. Firstly, it is recommended that transfusion protocols be reviewed and potentially revised to align with the latest evidence-based practices, considering single-donor protocols to minimize risks. Secondly, given that prematurity is the leading cause for hospitalization, management measures for preterm infants should be strengthened, including improved prenatal care, optimized delivery room practices, and enhanced neonatal surveillance. Thirdly, efforts should be made to expand preventive health measures in rural areas, such as iron supplementation and treatment with recombinant erythropoietin (EPO), to reduce the need for transfusions. Fourthly, while the current neonatal care practices are generally effective, further optimization is needed, especially for newborns with congenital anomalies. Fifthly, investing in the training and education of healthcare providers is crucial to ensure they can manage neonatal conditions appropriately. Sixthly, to address disparities in neonatal care between urban and rural areas, a strategic allocation of resources and investment in healthcare infrastructure is necessary. Lastly, ongoing monitoring of transfusion practices and neonatal outcomes, as well as further research to develop targeted interventions for neonates with congenital anomalies and refine transfusion practices, are essential.

It is important to note that our study focused on a specific regional context, which may influence the applicability of our findings to other settings with differing healthcare infrastructures and resource availability. While our results offer valuable insights into neonatal transfusion practices in Burundi, they should be considered within the context of our study's geographical and demographic scope. Although our sample size provided adequate power to detect medium to large effect sizes, consistent with the common variability observed in similar studies, we acknowledge that the sample size limits the generalizability of our findings to a broader population. Future studies with larger, possibly multicenter, cohorts could enhance the external validity of our results and allow for more nuanced subgroup analyses.

5. Conclusion

The present study offers a detailed examination of blood transfusion practices and their outcomes in neonates at Kamenge Teaching Hospital, Burundi. Our findings underscore the predominance of prematurity and anemia among transfused newborns, highlighting the critical need for targeted interventions to address these conditions. The low incidence of transfusion-related accidents (6.3%) affirms the effectiveness of current transfusion protocols in a resource-limited setting, aligning with global safety measures. However, the significant mortality rate (16.7%) among newborns with congenital anomalies underscores the urgent need for improved diagnostic capabilities and specialized care for these complex cases.

Our research contributes to the global dialogue on neonatal health by shedding light on the specific challenges faced in low-resource settings. It emphasizes the importance of context-specific approaches to neonatal care and advocates for the allocation of resources to enhance the quality of neonatal services, particularly in rural areas. The significance of our study lies in its potential to inform policy, guide clinical practice, and drive future research aimed at optimizing neonatal health outcomes. By identifying areas for improvement in transfusion practices and neonatal care, we hope to contribute to the ongoing efforts to reduce neonatal morbidity and mortality rates, ultimately enhancing the health and well-being of newborns in Burundi and similar settings.

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7. Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study. No financial or personal relationships, interests, or affiliations have influenced the planning, execution, interpretation, or writing of the report.

8. Data Availability Statement

The data underlying this study are available upon request due to ethical and privacy restrictions. Interested researchers may contact the corresponding author, Epipode Ntawuyamara (e-mail: epipode.ntawuyamara@ub.edu.bi), to request access to the data.

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