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Management of Malaria in Children with Sickle Cell Disease: Knowledge, Attitudes and Practices among Health Care Providers in Kisangani Health Centers, Democratic Republic of the Congo

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Abstract

Objective: This study aimed to assess the knowledge, attitudes, and practices of healthcare providers regarding the impact of sickle cell polymorphism on the prevalence, clinical characteristics, complications, treatment, and prevention of malaria in patients under 5 years of age. **Methods**: A cross-sectional survey was conducted from March 1, 2024, to June 30, 2024, among 97 volunteer healthcare providers out of approximately 400 medical staff working in 11 health facilities (both private and public) in Kisangani, where a newborn screening program had been implemented. A semi-structured questionnaire with end-closed questions was self-administered under the supervision of trained interviewers. The knowledge level was categorized as low, medium, or high, based on the number of questions answered correctly. Attitudes and practices were rated as satisfactory when respondents answered at least 70%

of the related questions correctly. Adequate agreement with the standard principles of clinical interventions indicated satisfactory attitudes and good practices. **Results**: The 97 respondents comprised 62 males (63.9%) and 35 females (36.1%), aged 30 to 39 years, of whom 36 (37.1%) were physicians (general practitioners and specialists) and 61 (62.9%) nurses. The level of knowledge about the complex relationship between malaria and sickle cell disease (SCD) was low in 23.7%, medium in 56.7%, and high in only 19.5% of participants. Their attitudes and practices were inadequate in 69.1%. However, statistically significant differences were associated with caregiver qualification (ORa = 3.04 [95% CI: 1.57 - 5.88]; P = 0.0009) and the health facilities surveyed (P = 0.0016; ORa = 2.29; 95% CI: 1.37 - 3.85). **Conclusion**: Awareness raising and capacity building of healthcare providers are needed to enhance malaria management among children with SCD in Kisangani, as current performance is unsatisfactory.

Keywords

Malaria, Childhood Sickle Cell Anemia, Care, Health Care Providers, Kisangani, Democratic Republic of Congo

1. Introduction

Sickle cell disease (SCD), also known as SS-anemia, is the most common genetic disorder in the African region, as highlighted by the World Health Organization (WHO) [1]. This region also bears a significant portion of the global malaria burden. In 2021, 95% of malaria cases and 96% of malaria deaths were recorded there [2]. The high prevalence of the hemoglobin S (HbS) gene in sub-Saharan Africa (SSA) is thought to be closely related to that of malaria in the region. There is an overlap between the epidemiology of malaria and that of SCD [3]-[5].

The literature reports the existence of a complex relationship and a balanced polymorphism between SCD and malaria, demonstrating a beneficial relationship in heterozygous carriers (AS) and a deleterious one in homozygous carriers (SS) [6]. AS carriers are associated with the most significant reduction in malaria-related mortality compared to a control population [7] [8]. Heterozygosity AS would constitute a selective advantage as it leads to significant resistance to *Plasmodium falciparum* malaria. Likely mechanisms include, among others, impaired development of the parasite at the blood stage, accelerated elimination of parasitized red blood cells, tolerance to malaria infection, and accelerated acquired immunity [9]. However, SS patients infected with Plasmodium have increased morbidity and mortality compared to AS or AA individuals [10]-[12]. This is due to the worsening of anemia and the occurrence of vaso-occlusive crises secondary to malaria infection [7]. Infection is thought to lead to worsening hemolysis, which is responsible for the accumulation of high levels of toxic heme [13].

Raising awareness and training health professionals are among the recommen-

dations proposed by the WHO to deal with both diseases [14]-[16]. An incidence of 2.2% of SS newborns was demonstrated in Kisangani in 2023 [3] [17]. In addition to endogamy as a factor increasing the incidence of SCD at birth, the role of malaria also remains predominant [17] [18]. A newborn screening program (NSP) for SCD is being implemented in Kisangani. Early clinical diagnosis (ECD), allowing for early clinical management (ECM), is possible [3]. Subsequently, knowledge of adequate ECM is required, meaning that healthcare providers need to have a clear understanding of the relationship between malaria and SCD in all its aspects [19]. In Kisangani, no recent study has evaluated this aspect. The literature on the level of knowledge, attitudes, and practices of healthcare providers regarding ECM of children appears scarce [19]. Thus, we aimed to assess the knowledge, attitudes, and practical practices of healthcare providers regarding ECM in malaria patients under 5 years of age in this study.

2. Patients and Methods

2.1. Study Setting

Kisangani, the capital of the Tshopo province, is situated in the northeastern region of the Democratic Republic of the Congo. SCD and malaria are major public health problems. A NSP is implemented to enable early detection of this disease in children under 5 years of age [3]. NSP and ECD activities have been implemented in some public and private healthcare facilities (HCFs).

2.2. Study Design

This is a descriptive cross-sectional survey that was conducted from May 1 to June 30, 2024, among healthcare providers practicing in 11 HCFs where NSP and ECD activities have been implemented. Components of this survey included provider responses related to the relationship between malaria and the epidemiology of SCD, factors explaining resistance or susceptibility of homozygous trait carriers to *Plasmodium falciparum* malaria, clinical signs of these two diseases, complications of malaria treatment in sickle cell patients, and knowledge about the detection and prevention of SCD. The protocol met the requirements of the Declaration of Helsinki and obtained authorization from the Ethics Committee of the University of Kisangani (UNIKIS/CE/005/2018) [3] [20]. The pre-approved, semi-structured, end-closed questions questionnaire was test-retested with 10 students from the Faculty of Medicine and Pharmacy of the University of Kisangani.

2.3. Participants and Interview Process

The study team members were trained to conduct semi-structured interviews using a case simulation. All medical physicians and nurses (approximately 400 people) from the HCFs concerned were eligible, provided they agreed to participate. In total, 97 individuals provided oral or written informed consent prior to the distribution of the questionnaire. The interviewer provided respondents with clear explanations of the survey's objectives and the content of the questionnaire.

Confidentiality and anonymity were guaranteed. Once the questionnaire was submitted, each participant was asked to complete it immediately (self-administration) within 20 minutes. Whenever one or more questions were not answered, the interviewer had to explain and give the respondent a little more time to fill in the missing answers before retrieving the questionnaire after thanking the respondent.

2.4. Operational Definitions

According to this study, a health care provider is someone who takes care of the needs or concerns of a child with SCD or malaria. The semi-structured questionnaire consisted of 15 questions on knowledge, three questions on attitudes, and three questions on practices. The knowledge score rating was categorized as high (>10 correct answers), medium (6 - 10 correct answers), and low (0 - 5 correct answers), corresponding to 5/15 questions per range. Attitudes and practices were rated as satisfactory when respondents answered at least 70% of the six related questions correctly. Adequate agreement with the standard principles of clinical interventions indicated a satisfactory attitude and good practice. The average level value of all participants was obtained by adding the weighted values assigned to each question. The proposed questions and answers are presented in Table 1.

2.5. Data Processing

To facilitate data processing, each question was coded as 1 for "yes" or "true" and 2 for "no" or "false". Data analysis was processed using Microsoft Excel and STATA software version 13. Percentages, chi-square test, and/or the exact Fisher test when the chi-square conditions were not met were obtained. The associations between the level of knowledge and the characteristics of the respondents were assessed using the odds ratio. Due to the small number of cases, elaborate adjusted regression models for potential confounding variables were not envisaged.

2.6. Limitations of the Study

The findings cannot be generalized to the entire Kisangani community, as the study only looked at caregivers working in the selected health facilities. As a result, opinions about other people's knowledge and attitudes were not recorded or taken into consideration in the study.

3. Results

Table 1 shows the respondents' sociodemographic and knowledge of SCD/malaria. Among the 97 respondents, the gender ratio was 1.7 (62 men to 35 females). The average age was 38.1 ± 7.7 (31 - 39) years, showing no statistically significant differences. The repartition based on the level of education (elementary, secondary, university), academic qualification (nurse, general practitioner, specialist), professional experience time, and type of HCF revealed inequalities that could anticipate significant differences in the assessment scores. Nurses were more represented than physicians (62.9% to 37.1%), and among physicians, the majority

were general practitioners compared to specialists (20.6% to 16.5%). The results also show that ECD activities are handled much more frequently in public HCFs compared to private ones (74.2% to 25.8%). Accordingly, they differed by their professional experience duration, with less than 5 years (28.9%), 6 - 10 years (26.8%), and more than 10 years (44.3%).

The average level values of all participants, obtained by adding the weighted values assigned to each question, showed that only 19.59% had a high level of knowledge, compared to a low level (23.1%) and a medium level (56.7%). There were, however, statistically significant differences associated with the qualifications of healthcare providers (aOR = 3.04 [95% CI: 1.57 - 5.88]; P = 0.0009) and the health facilities surveyed (P = 0.0016; aOR = 2.29; 95% CI: 1.37 - 3.85).

Table 1. Respondents' sociodemographic and knowledge of sickle cell disease/malaria among health care providers in Kisangani.

Variables	Sample size		LL %	ML %	HL %	OR	aOR	95% CI	P-Value
	N	%							
All participants	97	100	23.71	56.70	19.59				
Gender									
Male	62	63.92	24.19	58.06	17.74	1			0.665
Female	35	36.08	22.86	54.29	22.86	0.886			
Education									
Primary	29	29.9	31.03	58.62	10.34	0.372	3.04	1.57 - 5.88	0.011
Secondary	32	32.9	37.50	50.00	12.50	0.583			0.0009
University	36	37.1	5.56	61.11	33.33	1			
Qualification									
Nurse	61	62.9	34.43	54.10	11.48	0.38			
Generalist	20	20.6	5.00	75.00	20.00	0.654			0.005
Specialist	16	16.5	6.25	43.75	50.00	1			
Health Establishment									
Private	25	25.8	40.00	52.00	8.00	0.266			0.003
Public	72	74.2	18.06	58.33	23.61	1	2.29	1.37 - 3.85	0.0016

Table 2 shows the percentages of respondents who gave a correct answer to each question. Excellent knowledge (>70%) was only noted for questions 8 (Should LLIN be used routinely in patients with SCD?) and 6 (Patients with homozygous SCD (SS) frequently develop severe malaria), while question 13 was the most failed (Is it recommended to perform the G-6PD test in sickle cell patients routinely?). The average global knowledge score was approximately 48%. The percentages corresponding to attitudes and practices are presented in Table 3, showing an average of less than 50%.

Table 2. Knowledge assessment scores among health care providers towards children with sickle cell disease in Kisangani.

	Knowledge assessment	R	N	%
K01	Can malaria influence the prognosis of SCD and vice versa?	Y	33	34.02
K02	Can malaria worsen the prognosis of SCD?	Y	43	44.33
K03	Does the epidemiology of SCD overlap with that of malaria?	Y	30	30.93
K04	Is the prevalence of SCD high where malaria is endemic?	Y	45	46.39
K05	Heterozygous SCD (HbAS) frequently develops severe malaria.	N	57	58.76
K06	Patients with homozygous SCD frequently develop severe malaria.	Y	70	72.16
K07	Heterozygous SCD (HbAS) has developed a mutation associated with resistance against *Plasmodium falciparum.*	Y	31	31.96
K08	Should LLIN be used routinely in patients with SCD?	Y	94	96.91
K09	Should preventive treatment for malaria be routinely used in a child with SCD?	Y	53	54.64
K10	In your opinion, can malaria complicate the prognosis of SCD?	Y	32	32.99
K11	Do you think G-6PD should be given to children with SCD?	Y	33	34.02
K12	Can sulfadoxine-pyrimethamine be routinely administered in sickle cell patients as a preventive treatment for malaria in our environment?	N	47	48.45
K13	Is it recommended to routinely perform the G-6PD test in patients with SCD?	Y	27	27.84
K14	Can malaria cause vaso-occlusive crises in patients with SCD?	Y	55	56.70
K15	Can malaria increase the risk of mortality associated with SCD?	Y	60	61.86

Table 3. Attitudes and practice control assessment scores among health care providers towards children with sickle cell disease in Kisangani.

	Attitudes assessment			
A01	In your opinion, is SCD a serious disease in an environment endemic to malaria?	T	38	39.18
A02	Is it important to prioritize malaria prevention in children with SCD?	T	41	42.27
A03	Do you usually recommend the G-6PD test in patients with SCD?	T	34	35.05
	Practices assessment			
P01	Should LLIN be used routinely in patients with SCD?	T	63	64.95
P02	Do you recommend the use of insecticide-treated nets in sickle cell patients to prevent malaria?	T	64	65.98
P03	Do you prescribe preventive treatment for malaria in children with SCD?	T	37	38.14

4. Discussion

In the introduction of this study, we underlined that raising awareness and training health professionals on the complex interaction between malaria and SCD is among the recommendations proposed by the WHO to better patients with both diseases, particularly young children [14]-[16]. The main objective of this study was to assess the knowledge, attitudes and practices of health care providers in the city of Kisangani on ECM of malaria in SDC children under 5 years old.

Our data found low level of knowledge and inadequate attitudes and practices among the group of nurses and physicians who participated in the survey. Only 19% of the respondents could answer correctly more than 10 questions out of fifteen self-administered; the majority (56%) got a medium score rating corresponding to 6 - 10 correct answers, while 23% could not answer more than five questions. It has been observed that the level of knowledge was correlated with the qualifications of the respondents (higher among specialists and lower among nurses). The average knowledge score for the entire group surveyed is 48%. This result is not consistent with the findings by Kambale-Kombi *et al.* [4] who reported a high level of knowledge (92.9%) about how students transmit SDC. The deviation may result from the type of matter tested, SCD transmission in their case and SCD/malaria in our case.

In the study by Adewoyin *et al.*, in Nigeria [21], the level of knowledge of young graduates about SCD at the time of their hiring was low (17.8%). Here, the participants were young graduates, while ours were already practitioners. Druye *et al.* [18] indicated that the levels of knowledge of healthcare providers about the ECP of SCD range from low to medium, with a slightly lower level of knowledge among nurses compared to physicians, consistent with our findings. Statistically significant differences were associated with caregiver qualification (ORa = 3.04 [95% CI: 1.57 - 5.88]; P = 0.0009) and the health facilities surveyed (P = 0.0016; ORa = 2.29; 95% CI: 1.37 - 3.85). In the studies by Kambale-Kombi *et al.* [4] and Adewoyin *et al.* [21] only the level of education of respondents was associated with a good knowledge of SDC issues assessed.

The attitudes and practices scores were adequate in 69.1%. An attitude often reflects a psychological state influenced by daily experiences. When you live in an environment where you encounter children suffering from malaria, you can end up getting used to it to the point of finding it a normal situation that is not a cause for concern. Also, practices reflect the working conditions you face. It is essential to note that public HCF healthcare providers often benefit from regular training/retraining. This allows them to build capacity in several areas, including SDC.

Finally, as stated by many, self-administered questionnaire limitations include low response rates and non-response bias, which reduce the representativeness of the sample and limit the generalizability of the findings. It may also occur due to a lack of control over response quality, as respondents may misunderstand questions or provide socially desirable answers. Additionally, there's a risk of imposition, where the predefined questions limit respondents' ability to express their true experiences. To minimize these drawbacks, whenever one or more questions were not answered, the interviewer had to explain and give the respondent a little more time to fill in the missing answers before retrieving the questionnaire after thanking the respondent.

It should be noted that there is an urgent need not only to train qualified personnel in the care of sickle cell patients, but also to create reference centers for the care of sickle cell patients in countries where the sickle cell gene is particularly

widespread [7]. This would, among other things, allow access to specialized care for sickle cell patients. Universal access to such care will ideally only be possible in Africa in a networked system encompassing peripheral structures at the first level of contact with patients (community health centers).

5. Conclusion

This study shows that health care providers' knowledge of malaria ECP in children with SCD is moderate. Their practice and attitude are not satisfactory. Awareness raising and capacity building of health care providers are needed to boost malaria PKU in children with SCD in Kisangani.

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Authors' Contributions

This work was carried out in collaboration. **ETK, AOM, JPAO,** and **JNK** designed, and supervised the study, **ETK, NND, ATT, RMD,** and **SBA** analyzed the data and wrote the first draft of the manuscript. All authors have read and approved the final version of the manuscript.

Data Availability

Raw data may be obtained from the corresponding author upon reasonable reason.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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