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Risk Factors for Multiple Hospitalizations among Adolescents with Sickle Cell Disease Followed in a Reference Hospital, Abidjan (Côte d'Ivoire)

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Abstract

Introduction: Sickle cell disease, a chronic genetic disorder, exposes adolescents to frequent acute complications requiring repeated hospitalizations. The general objective of this study was to identify the risk factors for multiple hospitalizations in order to improve the prognosis of these adolescents. **Methods:** A retrospective analytical study was conducted in the pediatric outpatient department of Cocody University Hospital over a 24-month period from January 2023 to December 2024. All adolescents with sickle cell disease followed in the service were included. Sociodemographic and medical follow-up data were analyzed using Excel and SPSS.20 software. Fisher's exact test was used to compare proportions, with a significance level set at 5%. Multiple hospitalization was defined as at least two admissions during the study period. **Results:** Among 134 children with sickle cell disease seen in pediatric outpatient consultation, 60 adolescents aged 10 to 15 years (mean age: 12.7 years) were included in the study. The sex ratio was 1.14, and 66.7% had a normal schooling level. Sickle cell disease was generally diagnosed around the age of 3 years and 9 months, mainly during bone pain crises (46.7%) or anemia (36.7%). The frequency of multiple hospitalizations was 23.3%. Three factors were significantly associated with repeated hospitalizations: low socioeconomic status ($p = 0.001$), poor quality of medical follow-up ($p = 0.006$), and poor treatment adherence

(p = 0.001). No significant association was found with mothers' education (p = 0.542), fathers' education (p = 0.195), type of background therapy (p = 0.061), or vaccination coverage (p = 0.666). **Conclusion:** Repeated hospitalizations among adolescents with sickle cell disease are strongly influenced by avoidable factors linked to socioeconomic context and the quality of medical follow-up. Targeted interventions focusing on therapeutic education and family support are necessary to reduce morbidity associated with these hospitalizations.

Keywords

Sickle Cell Disease, Adolescents, Medical Follow-Up, Multiple Hospitalizations

1. Introduction

Sickle cell disease is a complex genetic hematological disorder characterized by abnormal hemoglobin structure, leading to chronic hemolysis and severe anemia [1]. It is one of the most common genetic diseases worldwide, with particularly high prevalence in sub-Saharan Africa, where about 80% of cases are concentrated [2]. According to the World Health Organization, nearly seven million people are affected, making sickle cell disease a major public health priority in many low-resource countries [3] [4].

Without appropriate management, between 50% and 75% of children with sickle cell disease die before the age of five. However, recent diagnostic and therapeutic advances now enable more children to reach adolescence [5]. This critical stage of development is marked by profound physical, psychological, and social changes, making adolescents particularly vulnerable.

In patients with sickle cell disease, adolescence often coincides with an increase in acute episodes, chronic complications, and a higher risk of hospitalization. These repeated hospitalizations significantly impact school performance, psychosocial well-being, and impose heavy economic and emotional burdens on families and healthcare systems [6].

Within this context, the present study aimed to identify factors associated with multiple hospitalizations among adolescents with sickle cell disease followed in a pediatric service, with the goal of contributing to improved management through targeted preventive strategies.

2. Methods

This study was conducted in the pediatric consultation department of Cocody University Hospital, specifically at the Gynecology-Obstetrics and Pediatrics Center (PGOP). It was a retrospective descriptive and analytical study covering the period from January 1, 2023, to December 31, 2024 (24 months). Follow-up was

considered good when at least four consultations were conducted per year. Adherence was considered good if prophylaxis with folic acid and Tanakan or hydroxyurea was regular. Vaccination status was considered adequate if up to date with both the Expanded Program on Immunization in Côte d'Ivoire [7] and additional vaccines recommended for patients with sickle cell disease [8].

The study population consisted of all children with sickle cell disease followed in consultation during the study period. The inclusion criteria were adolescents aged 10 to 15 years with a known hemoglobin electrophoresis profile and regular follow-up in the service. We limited the age to 15 years, as adolescents over 15 years old were managed by adult hematologists and not in the pediatric department. The exclusion criteria were incomplete or missing records and the absence of hemoglobin electrophoresis results.

Variables studied included:

- **Sociodemographic data:** age at admission, sex, school level, place of residence.
- **Parental data:** socioeconomic conditions, occupation, educational level.
- **Medical history:** age and circumstances of diagnosis, quality of follow-up, background treatment, vaccination coverage, treatment adherence.
- **Follow-up events**: complications, number of consultations, number of hospitalizations.

Data were collected using an individual survey form from medical records. Entry and analysis were carried out using Excel and SPSS 20.0. Proportions were calculated for qualitative variables, while means, standard deviations, and ranges were calculated for quantitative variables.

Socioeconomic status was assessed according to the classification of Gayral-Taminh *et al.* [9].

Multiple hospitalization was defined as at least two admissions for sickle cell-related complications during the study period. Fisher's exact test was used to compare proportions, with significance set at 5% ($p < 0.05$). Confidentiality was ensured by anonymized survey forms.

3. Results

During the study period, 134 children with sickle cell disease were followed in the pediatric department, of which 60 were adolescents aged 10 to 15 years, thus meeting our inclusion criteria.

3.1. Sociodemographic Data

The 10 to 12 age group was the most represented, accounting for 40% of the sample. The mean age was 12.7 ± 1.8 years, with extremes ranging from 10 to 15 years. The sex ratio was 1.14. In 66.7% of cases, adolescents were enrolled in regular schooling. The municipality of Abobo was the place of residence for 26.7% of the participants. The sociodemographic characteristics of the patients are presented in Table 1.

Table 1. Distribution of adolescents according to sociodemographic data.

Sociodemographic Data	Frequency (n)	Percentage (%)
Age group		
[10 - 12 years]	24	40
[12 - 14 years]	18	30
≥ 14 years	18	30
Sex		
Male	32	53.3
Female	28	46.7
Schooling		
Regular schooling	40	66.7
School delay	18	30
School dropout	2	3.3
Place of residence		
Abobo	16	26.7
Cocody	12	20.0
Adjamé	8	13.3
Yopougon	8	13.3
Koumassi	4	6.7
Other municipalities (Abidjan)	6	10
Other cities	6	10

3.2. Parental Data

Consanguinity was reported in 33.3% of cases. The socioeconomic status of the families was low in 33% of situations. Mothers were traders in 33.3% of cases and had no formal education in 40.7% of cases. Fathers were civil servants in 44.4% of cases and had a secondary level of education in the same proportion. Parental information is summarized in Table 2.

Table 2. Distribution of patients according to parental data.

Parental Data	Frequency (n)	Percentage (%)
Parental consanguinity		
Yes	20	33.3
No	40	66.7
Socioeconomic status		
Low	20	33
Medium	34	57
High	6	10

Continued

Mother's occupation		
Trader	18	33.3
Civil servant	10	18.5
Housewife	14	26
Self-employed	18	30
Father's occupation		
Trader	10	18.5
Civil servant	24	44.4
Self-employed	12	22.2
Farmer	4	7.4
Unemployed	10	16.7
Father's education level		
No formal education	14	26
Primary	6	11.1
Secondary	24	44.4
University	16	26.7
Niveau d'instruction des mères		
No formal education	22	40.7
Primary	16	26.6
Secondary	12	22.2
University	10	16.7

3.3. Data on Sickle Cell Disease and the Content of Medical Follow-Up

Adolescents with sickle cell disease had an SS electrophoretic profile in 53.4% of cases, followed by the SFA2 genotype in 30% of cases. The mean age at diagnosis was 3 years and 9 months, with extremes ranging from 6 months to 10 years. The most common circumstances leading to diagnosis were osteoarticular pain (46.7%) and anemia (36.7%). The quality of medical follow-up was poor in 53.3% of cases. The combination of Acfol and Tanakan was used as long-term treatment in 63.3% of patients, with good adherence observed in 66.7% of cases. Immunization coverage was poor in 86.7% of cases. The major complications observed during the year were vaso-occlusive crises (73.3%) and recurrent infections (66.7%). Patients had four follow-up consultations in 43.3% of cases, and 23.3% were hospitalized at least twice. Table 3 summarizes the follow-up content.

Table 3. Distribution of patients according to follow-up content.

Follow-up Content	Frequency (n)	Percentage (%)
Quality of follow-up		
Poor	32	53.3
Good	18	46.7
Type of long-term treatment		
Acfol + Tanakan	38	63.3
Acfol + Hydroxyurea	22	36.7
Adherence to long-term treatment		
Good	40	66.7
Poor	20	33.3
Vaccination coverage		
Good	8	13,3
Poor	52	86,7
Complications during follow-up		
Painful bone crisis	44	73.3
Acute chest syndrome (ACS)	6	10
Stroke	2	3.3
Priapism	2	3.3
Recurrent infection	40	66.7
Osteoarticular infection	6	10
Number of follow-up consultations (per year)		
One consultation	6	10
Two consultations	10	16.5
Three consultations	18	30
Four consultations	26	43.3
Number of hospitalizations		
Zero hospitalization	26	43.3
One hospitalization	20	33.3
Two hospitalizations	6	10
More than two hospitalizations	8	13.3

3.4. Risk Factors for Repeated Hospitalizations

Repeated hospitalizations among adolescents were significantly associated with the parents' socioeconomic status ($p = 0.001$), the quality of medical follow-up ($p = 0.006$), and treatment adherence ($p = 0.001$). In contrast, no significant correlation was observed with the educational level of the mothers ($p = 0.542$) or fathers ($p = 0.195$), the type of long-term treatment ($p = 0.061$), or vaccination coverage ($p = 0.666$). The various factors associated with the number of hospitalizations are

detailed in Table 4 and Table 5.

Table 4. Distribution of patients according to risk factors for multiple hospitalizations.

Risk Factors	Number of Hospitalizations		p-value	OR [95% CI]
	0 to 1 (n = 46)	≥2 (n = 14)		
Socioeconomic Level				
High or Medium	36 (90%)	4 (9%)	0.001	8.59 [1.97; 46.04]
Low	10 (50%)	10 (50%)		
Mother's Educational Level				
None or Primary	28 (73.7%)	10 (26.3%)	0.542	0.62 [0.12; 2.60]
Secondary or University	18 (81.8%)	4 (18.2%)		
Father's Educational Level				
None or Primary	13 (65%)	7 (35%)	0.195	0.40 [0.09; 1.62]
Secondary or University	33 (82.5%)	7 (17.5%)		
Quality of Medical Follow-up				
Good	26 (92.9%)	2 (7.1%)	0.006	7.55 [1.43; 76.98]
Poor	20 (62.5%)	12 (37.5%)		
Type of Long-term Treatment				
Acfol + Tanakan	26 (68.4%)	12 (31.6%)	0.061	0.22 [0.02; 1.17]
Acfol + Hydroxyurea	20 (90.9%)	2 (9.1%)		
Vaccination Coverage				
Good	7 (87.5%)	1 (12.5%)	0.666	2.30 [0.25; 113.07]
Poor	39 (75%)	13 (25%)		
Treatment Adherence				
Good	36 (90%)	4 (10%)	0.001	8.59 [1.97; 46.04]
Poor	10 (50%)	10 (50%)		

Table 5. Simple multivariate logistic regression.

Variables	Number of hospitalizations		OR (CI 95%)	p-value
	0 - 1	≥2		
High or middle socio-economic level	36	4	-	0.32
Low socio-economic level	10	10	5.8 (1.4 - 24.0)	0.015
Mother's education level (None or primary)	28	10	-	0.54
Father's education level (None or primary)	13	7	-	0.19
Good quality of follow-up	26	2	-	0.68
Poor quality of follow-up	20	12	4.9 (1.1 - 22.1)	0.035

Continued

Baseline treatment (Acfol + Hydroxyurea)	20	2	-	1.17
Baseline treatment (Acfol + Tanakan)	26	12	-	0.06
Poor vaccination coverage	39	13	-	0.66
Good therapeutic adherence	36	4	-	1.00
Poor therapeutic adherence	10	10	6.7 (1.6 - 27.8)	0.009

In multivariate analysis, significant associations were found for low socio-economic status (OR = 5.8, 95% CI: 1.4 - 24.0, p = 0.015), poor quality of follow-up (OR = 4.9, 95% CI: 1.1 - 22.1, p = 0.035), and poor therapeutic adherence (OR = 6.7, 95% CI: 1.6 - 27.8, p = 0.009).

4. Discussion

Considerations on sample size and statistical power: In this study, the sample size is relatively modest, with only 14 cases of rehospitalization. A small sample size can limit the statistical power of the tests used, making it more difficult to detect significant associations, even if they exist. As a result, the obtained p-values should be interpreted with caution. A larger sample would allow for better estimation of true effects and increase the reliability of the results. Future research with larger sample sizes and appropriate power analyses are needed to confirm these findings and assess their generalizability. However, despite these limitations, the results provide relevant insights into the understanding of factors associated with repeated hospitalizations among adolescents with sickle cell disease.

A slight male predominance with a sex ratio of 1.14 was observed. This result is comparable to that reported by Babela JM [10], who found a sex ratio of 1.2, as well as by Alain F [11], with a sex ratio of 1.3. Conversely, Kpakoutou NA [12], in Bamako, noted a female predominance. These different observations confirm that the transmission of hemoglobin S is independent of sex, thus highlighting the autosomal mode of inheritance of sickle cell disease. School attendance was normal in 66.7% of patients, a result similar to that obtained by Elie ADA [13] in Lome, who reported a good academic level in 85.72% of cases. However, repeated hospitalizations could compromise this good academic performance.

The most frequent circumstances leading to the discovery of sickle cell disease were osteoarticular pain and anemia, observed in 46.7% and 36.7% of cases, respectively. The mean age at diagnosis was 3 years and 9 months, with extremes ranging from 6 months to 10 years. This finding is consistent with the observations of several authors [11] [14] [15]. These results highlight the delay in sickle cell disease screening in our regions. In contrast, in Europe, particularly in France, neonatal screening is systematic [16]. In our context, the disease is often revealed during complications. This late diagnosis underscores the shortcomings of our

healthcare system. Moreover, the presence of recurrent anemia and abdominal pain in children should systematically prompt practitioners to perform hemoglobin electrophoresis, which remains insufficiently practiced.

This study revealed a notable frequency of repeated hospitalizations (23.3%) among adolescents with sickle cell disease. Recent studies have highlighted the variability in the use of healthcare services among adolescents with sickle cell disease, emphasizing the importance of better understanding the factors contributing to frequent hospitalizations. Guarino *et al.* [17] observed that some young patients with sickle cell disease frequently visited the emergency department and experienced repeated hospitalizations, suggesting that these patients may benefit from more targeted medical follow-up strategies to improve their clinical outcomes and reduce readmissions.

Our study found significant associations between these hospitalizations and three main factors: low socio-economic status, poor quality of medical follow-up, and insufficient therapeutic adherence.

The socioeconomic conditions were modest in 57.0% of cases and low in 33.0% of cases. These findings are consistent with the study by Babela JM [10], which reported a low socioeconomic level in 39.4% of families, moderate in 51.2%, and high in the remaining cases. The relationship between socioeconomic status and the frequency of hospitalizations among sickle cell patients is well documented. A multicenter study conducted in the United States revealed that financial difficulties, such as paying medical bills, were significantly associated with increased hospital admissions and readmissions in children with sickle cell disease [18]. Another multicenter study conducted in West and Central Africa found that a high poverty index was an independent risk factor for mortality before the age of 20 in children with sickle cell disease [19]. These findings highlight the impact of social determinants on the health of sickle cell patients.

The quality of medical follow-up is also a crucial determinant. In our study, more than half of the adolescents (53.3%) had insufficient follow-up. This result is similar to that reported by Akolly D *et al.* [20], who noted irregular follow-up in 68% of cases. This is a concerning finding, as regular medical monitoring is essential for preventing complications and ensuring effective disease management. Studies have shown that adolescents with sickle cell disease who have irregular follow-up are at a higher risk of hospitalizations [21] [22]. Given that sickle cell disease is a chronic condition, improving outcomes depends on consistent follow-up care to prevent life-threatening complications. This observation is supported by Mbiya-Mukinayi *et al.* [23], who demonstrated that regular and continuous medical follow-up for adolescents in the Democratic Republic of Congo could improve the quality of life for these patients.

Therapeutic adherence remains a major challenge, particularly among adolescents. A study demonstrated that adherence to hydroxyurea treatment was associated with a significant reduction in hospitalizations and an improvement in quality of life among young people with sickle cell disease [24]. However, treat-

ment adherence can be influenced by various factors, including understanding of the disease, family support, and the parents' socioeconomic status. Acute complications of sickle cell disease, such as vaso-occlusive crises, were frequent and led to high hospitalization costs, highlighting the critical importance of good therapeutic adherence to prevent these complications [25].

Some factors, such as vaccination coverage, parental education level, and the type of background treatment, did not show a significant association with the frequency of hospitalizations in our study.

However, the low vaccination coverage (86.7%) is concerning, given that sickle cell disease significantly increases the risk of infectious complications. It is therefore essential to strengthen awareness through therapeutic education and conduct advocacy efforts to make these vaccines free for children with sickle cell disease.

Regarding parental education, a study by L. C. Ollandzobo Ikobo *et al.* [25] found that treatment and follow-up adherence were significantly poorer when the father's education level was primary school or lower. Although adolescents gain independence from their parents, parental motivation remains a crucial factor in helping them develop awareness and responsibility regarding their illness. Yet, parental education level and family socioeconomic status strongly influence this motivation, especially in the context of a chronic illness such as sickle cell disease [26].

Background treatment was mainly based on the combination of Acfol and Tanakan in 63.3% of cases. This may be explained by the unavailability of hydroxyurea and the families' unfavorable socioeconomic conditions. Complications observed during follow-up such as bone pain crises (73.3%), acute chest syndrome (10%), stroke (3.3%), and recurrent infections (66.7%) are associated with high mortality rates in the literature [27], justifying intensified treatment, particularly through the introduction of hydroxyurea. This approach is especially relevant in developing countries, where limited technical resources and frequent shortages of blood products make transfusion exchanges and stem cell transplants difficult. Therefore, the use of hydroxyurea should be promoted and its indications expanded.

These studies highlight the need to develop individualized follow-up strategies and better management of healthcare resources for this vulnerable population. Tanabe *et al.* [28], redefined the categories of emergency service use based on the intensity of visits, identifying high-risk groups requiring specific care to reduce the frequency of hospitalizations.

5. Conclusion

Low socio-economic status, inadequate quality of medical follow-up, and poor treatment adherence appear to be significantly associated with repeated hospitalizations in our study population. As these factors are mostly modifiable, they should be given particular attention in management strategies. It is essential to strengthen regular medical follow-up, improve access to healthcare, and develop

therapeutic education programs tailored to the socio-economic realities of families.

Conflicts of Interest

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

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