

ORIGINAL ARTICLE

Caregiver Knowledge, Adherence, and Barriers to Hydroxyurea Therapy Among Children with Sick Cell Disease at the University of Benin Teaching Hospital, Benin City, Nigeria**Lilian Ezeuko, Magdalene Odunvbun, Vitalis Chukwuma Ezeuko**

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ABSTRACT

Background: Hydroxyurea (HU) therapy is an evidence-based treatment for sickle cell disease (SCD) that reduces the frequency of vaso-occlusive crises and improves haematological outcomes. Despite its proven benefits, adherence remains suboptimal, and caregiver knowledge influences treatment success. Limited data exist on caregiver awareness, adherence, and barriers to HU therapy in Nigerian children with SCD.

Objective: To assess caregiver knowledge, level of adherence, and reported barriers to hydroxyurea therapy among children with sickle cell disease at the University of Benin Teaching Hospital, Benin City, Nigeria.

Methods: This hospital-based cross-sectional study was conducted at the University of Benin Teaching Hospital, Benin City, Nigeria. One hundred children with sickle cell disease receiving hydroxyurea therapy and their caregivers were enrolled. Data on caregiver knowledge, level of adherence and self-reported barriers to HU therapy among children with SCD were collected using a structured interviewer-administered questionnaire. Good adherence was defined as missing ≤ 1 dose in the preceding 7 days and ≤ 4 doses in the preceding one month. Data were analysed using SPSS version 26.0. Statistical significance was set at $p < 0.05$.

Results: The mean age of children was 10.35 ± 4.34 years, with 54% males. All caregivers (100%) had heard of hydroxyurea therapy, but only 56% knew its purpose, and over half (52%) rated their knowledge as poor. Good adherence was observed in 58% of children. Commonly reported barriers included inconsistent availability of hydroxyurea (72%) and missed doses due to running out of medication. Most caregivers (82%) reported significant improvement in their children, and 95% expressed satisfaction with therapy.

Conclusion: Awareness of HU is high among caregivers, but knowledge gaps and medication access barriers limit optimal adherence. Strengthening caregiver education and ensuring consistent HU availability are essential to improve treatment outcomes in children with SCD.

Keywords: Adherence, Caregiver knowledge, Hydroxyurea, Sickle cell disease.

INTRODUCTION

Sickle cell disease (SCD) is a hereditary haemoglobinopathy resulting from a point mutation in the β -globin gene, leading to the production of abnormal haemoglobin S (HbS). Under conditions of deoxygenation, HbS polymerizes, causing red blood cells to assume a sickled shape, which leads to chronic haemolysis, vaso-occlusion, and progressive organ damage.¹ SCD remains one of the most common

genetic disorders globally, with the highest burden occurring in sub-Saharan Africa.² Nigeria bears the largest global burden of SCD, accounting for approximately 150,000 new births annually, representing a significant public health challenge.² In affected children, SCD is associated with recurrent painful crises, acute chest syndrome, severe anaemia, increased susceptibility to infections, stroke, and reduced life expectancy.^{1,3}

Hydroxyurea has emerged as the cornerstone of disease-modifying therapy for SCD. Initially developed as an antineoplastic agent, hydroxyurea exerts its therapeutic effects in SCD primarily by increasing foetal haemoglobin (HbF) production, which inhibits HbS polymerization and reduces red cell sickling.³ Clinical trials have demonstrated that hydroxyurea significantly reduces the frequency of vaso-occlusive crises, acute chest syndrome episodes, blood transfusion requirements, and hospitalizations in both adults and children with SCD.^{3,4,5} The landmark Multicenter Study of Hydroxyurea (MSH), conducted in the United States in 1995 among adults with sickle cell anaemia, demonstrated significant reductions in the frequency of painful crises and other complications among treated patients.⁴

The World Health Organization (WHO) recommends hydroxyurea as an essential medicine for the management of SCD and emphasizes its role in reducing morbidity and mortality.⁶ In Nigeria and other low- and middle-income countries, hydroxyurea therapy is increasingly available in tertiary health facilities such as the University of Benin Teaching Hospital (UBTH), Benin City. However, the benefits of hydroxyurea are highly dependent on sustained adherence to therapy. Because hydroxyurea is a long-term daily medication, consistent use is necessary to maintain elevated HbF levels and achieve optimal clinical outcomes. Adherence, defined by the WHO as the extent to which a person's behaviour corresponds with agreed recommendations from a healthcare provider, is a major determinant of therapeutic success in chronic diseases.⁶ In paediatric SCD, adherence is particularly complex because it involves both the child and the caregiver. Factors influencing adherence may include caregiver knowledge, beliefs about medication safety, fear of side effects, forgetfulness, financial constraints, pill burden, and healthcare system limitations.⁷ In resource-limited settings, irregular drug availability and cost barriers may further compromise consistent medication use.⁷ Poor adherence to hydroxyurea therapy has been associated with lower HbF levels, persistent vaso-occlusive episodes, increased emergency visits, and higher hospitalization rates.⁸ Studies conducted in different settings report varying adherence rates, often ranging between 49% and 80%, depending on the measurement method used.^{8,9} Importantly, interventions such as patient education, counselling, and structured follow-up have been shown to improve adherence and clinical outcomes.⁹

Despite growing evidence supporting hydroxyurea therapy, data on adherence among Nigerian children with SCD remain limited. Most available studies in sub-Saharan Africa focus on utilization rather than sustained adherence.¹⁰ Understanding adherence patterns in specific local contexts is crucial because socio-cultural, economic, and health system factors vary significantly across regions. UBTH serves as a major referral centre in southern Nigeria, providing comprehensive care for

children with SCD, including hydroxyurea therapy and routine monitoring. However, the extent to which paediatric patients adhere to prescribed hydroxyurea regimens in this setting has not been adequately documented.

Investigating adherence to hydroxyurea therapy among children with SCD at UBTH is therefore essential. Identifying the level of adherence and the factors influencing it will provide evidence to guide targeted interventions aimed at improving treatment outcomes. Such interventions may include caregiver education programmes, improved counselling services, reminder systems, and policy measures to enhance medication accessibility. Ultimately, improving adherence to hydroxyurea therapy could significantly reduce SCD-related morbidity and enhance quality of life among affected children in Benin City and similar settings. Therefore, this study aimed to assess caregiver knowledge, level of adherence, and reported barriers to hydroxyurea therapy among children with sickle cell disease attending the Paediatric Haemato-oncology Clinic of the University of Benin Teaching Hospital, Benin City, Nigeria.

METHODS

Study Design

This hospital-based descriptive cross-sectional study was conducted among children with sickle cell disease receiving hydroxyurea therapy at the Paediatric Haemato-oncology Clinic of UBTH between August and December, 2025.

Study Area

Benin City is the capital of Edo State in southern Nigeria, with an estimated population of over 1.7 million people. Sickle cell disease remains a significant public health concern in Nigeria, with an estimated prevalence of 2–3% among newborns. In Edo State, care for children with sickle cell disease is primarily provided at secondary and tertiary health facilities, with comprehensive management—including hydroxyurea therapy—largely available at tertiary centres such as the University of Benin Teaching Hospital (UBTH). The study was conducted at the Paediatric Haemato-oncology Clinic of University of Benin Teaching Hospital (UBTH), a tertiary referral centre located in Benin City, Edo State, Nigeria. UBTH provides comprehensive care for children with sickle cell disease, including routine follow-up, laboratory monitoring, and hydroxyurea therapy.

Study Population

The study population comprised children aged 1–18 years diagnosed with sickle cell disease (HbSS or HbSC) who were receiving hydroxyurea therapy and attending the Paediatric Haemato-oncology Clinic at the

University of Benin Teaching Hospital, Benin City, Edo State during the study period. All children aged 1–18 years with a confirmed diagnosis of sickle cell disease (HbSS or HbSC) who had been on hydroxyurea therapy for at least three months prior to the study were eligible. Caregivers who provided informed consent (and assent from children where applicable) were included. Children who were critically ill at the time of data collection or whose caregivers declined participation were excluded from the study.

Sample Size Determination

The sample size was calculated using the single population proportion formula:

$$N = \frac{Z_{\alpha}^2 pq}{d^2}$$

where N is the minimum sample size, Z_{α} is the standard normal deviation at 95% confidence interval (1.96), p is the prevalence of hydroxyurea utilization among patients with sickle cell disease in Nigeria (43%) reported by Nnodu et al.¹⁰ In the absence of reliable published data on hydroxyurea adherence in the study setting at the time of sample size estimation, prevalence of hydroxyurea utilization (43%) reported by Nnodu et al.¹⁰ was used as a proxy.

$q = 1 - p$, and d is the margin of error set at 10%.

Substituting the values gave a minimum sample size of 94 participants, which was increased to 100 to account for potential non-response and incomplete questionnaires. Finite population correction was not applied as the sampling frame was sufficiently large relative to the calculated sample size.

Sampling Technique

A convenience sampling technique was used. All eligible children with sickle cell disease receiving hydroxyurea therapy who attended the clinic during the study period and whose caregivers consented were consecutively recruited until the required sample size was achieved.

Data Collection Instrument

Data were collected using a structured, interviewer-administered questionnaire. The questionnaire was developed based on literature review and adapted from previously published studies assessing hydroxyurea adherence. It was pretested among 10 caregivers of children with SCD attending a different clinic within the hospital to ensure clarity and appropriateness. Necessary modifications were made following pretesting.

Section A obtained socio-demographic information.

Section B assessed clinical history and duration of hydroxyurea use.

Section C assessed adherence using caregiver-reported missed doses over the previous 7 days and one month.

Section D explored factors affecting adherence including caregiver knowledge of HU therapy, drug availability, cost, side effects, and caregiver-related challenges.

Definition of Adherence

Adherence was assessed using caregiver recall of missed doses over the preceding 7 days and one month. Good adherence was defined as missing ≤ 1 dose in the previous 7 days and ≤ 4 doses in the previous one month. The 80% threshold is widely used in adherence research as a standard cut-off for adequate adherence in chronic disease management.^{7,8}

Data Analysis

Data were entered and analysed using Statistical Package for Social Sciences (SPSS) version 26.0. Adherence status was computed by categorizing participants based on reported missed doses according to the predefined criteria and coded as binary outcome (good vs poor adherence) for analysis. Descriptive statistics (mean, standard deviation, frequency, and percentages) were used to summarize variables. Chi-square test was used to assess associations between categorical variables. Logistic regression analysis was not performed as there was no statistically significant association between socio-demographic characteristics of caregivers or children and adherence to hydroxyurea therapy. Statistical significance was set at $p < 0.05$.

Ethical Considerations

Ethical approval was sought and obtained from the Health Research Ethics Committee of University of Benin Teaching Hospital (NHREC-UBTH – HREC/24/12/2022B). Informed consent was obtained from caregivers, and assent was obtained from children aged 7 years and above. The study was conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki.

RESULTS

Socio-demographic characteristics of the study participants

Forty-six (46%) of the children were aged 7-12 years; thirty-two (32%) were aged 13-18 years. The mean age of the children was 10.35 years $\pm$ 4.34. Fifty-four (54%) of the children were males, while forty-six (46%) were female. Half (50%) of the caregivers were 45-54 years of age, with mean age being 42.9 years $\pm$ 7.39. The majority of caregivers, 98 (98%) were females, while 2 (2%) were males. Seventy-nine (79%) of primary caregivers had at least secondary level of education. Most, 77 (77%), of the caregivers had only one child

with SCD, while the rest, 23 (23%), had two children with SCD. Two-thirds (66%) of the caregivers had a family monthly income of more than 150,000 naira. Thirty-nine (39%) of the caregivers belonged to the middle socio-economic class (Oyededeji classification). See table I.

Caregivers' knowledge and awareness of hydroxyurea (HU) therapy

All (100%) of the caregivers of children with SCD have heard about hydroxyurea therapy for SCD. Most (98%) of caregivers were informed about HU by a doctor, while 2% heard about HU from other sources. Nonetheless, only 56% of the caregivers knew the purpose of HU therapy. Out of the 56 caregivers who knew the purpose of HU therapy, most (91.1%) of them declared that the purpose of HU therapy for SCD children is to prevent/reduce crises. More than half (52%) of the caregivers of children with SCD self-rated their knowledge of HU therapy as poor, 39% as fair, and 9% as good. Table II.

Children's adherence to Hydroxyurea therapy

Thirty-six percent (36%) of the children with SCD had been taking HU for 1-3 years; 30% had been taking HU for > 3 years. Most (86%) of the children with SCD took HU twice daily. A greater proportion (63%) of the children with SCD missed no dose in the last 7 days. A greater proportion (69%) of the children with SCD had missed 1-4 doses in the last one month. The main reason given by the caregivers (28%) for missed doses was that the children had run out of the medicine, although slightly more than half (51%) did not have any reason. Most (94%) of the caregivers of children with SCD did not use reminders for giving HU. Most (83%) of the children with SCD attend regular follow-up clinic visits. Based on the predefined criteria using caregiver recall of missed doses over the preceding 7 days and one month, 58 (58%) of the children demonstrated good adherence to hydroxyurea therapy, while 42 (42%) had poor adherence. See table III.

Caregiver-reported barriers to hydroxyurea therapy

Most (72%) of the caregivers reported that HU is not always available at the hospital/pharmacy. Twenty-eight (28%) reported that the cost of HU was not affordable for their family; the majority (72%) reported that the cost was affordable for their family. Sixteen percent (16%) of the caregivers reported that they have noticed side effects in the child with HU use. Side effects reported include abdominal discomfort, crises despite intake, and low PCV. Only 6% of the caregivers had a challenge remembering daily doses of HU. Twenty-four percent (24%) of the caregivers reported that their child resists taking HU. Most (90%) of the caregivers felt that they receive enough support from health workers regarding HU use. see table IV.

Caregivers perceived benefits and satisfaction with HU therapy.

Most (82%) of the caregivers noticed significant improvement in their child after starting HU therapy. Most (95%) of the caregivers are satisfied with HU therapy for their child. Likewise, most (89%) of the caregivers would recommend HU therapy for other children with SCD. Table V.

Association between Socio-demographic factors of participants and adherence to HU therapy.

A greater proportion (31, 66%) of children aged 7-12 years had good adherence to HU therapy. However, the association between age of child and adherence to HU therapy was not statistically significant ($\chi^2 = 2.522$, $p = 0.282$). A greater proportion (32, 59.3%) of male children had good adherence to HU therapy. However, the association between child's gender and adherence to HU therapy was not statistically significant ($\chi^2 = 0.076$, $p = 0.840$). A greater proportion (22, 66.7%) of children whose caregivers are aged 35-44 years had good adherence to HU therapy. However, the association between age of caregiver and child's adherence to HU therapy was not statistically significant ($\chi^2 = 2.392$, $p = 0.302$). A greater proportion (21, 63.6%) of children whose caregivers were educated up to tertiary level had good adherence to HU therapy. However, the association between caregivers' highest level of education and child's adherence to HU therapy was not statistically significant ($\chi^2 = 1.369$, $p = 0.504$). A greater proportion (17, 68%) of children whose caregivers had two children with SCD also had good adherence to HU therapy. However, the association between number of SCD children of caregiver and child's adherence to HU therapy was not statistically significant ($\chi^2 = 1.368$, $p = 0.350$). A greater proportion (39, 62.9%) of children whose caregivers claim to know the purpose of HU therapy had good adherence to HU therapy. However, the association between caregiver's knowledge of purpose of HU therapy and child's adherence to HU therapy was not statistically significant ($\chi^2 = 1.058$, $p = 0.317$). A greater proportion (41, 63.1%) of children with caregivers whose family monthly income was >150,000 naira had good adherence to HU therapy. However, the association between caregiver's family monthly income and child's adherence to HU therapy was not statistically significant ($\chi^2 = 1.965$, $p = 0.204$). A greater proportion (18, 64.3%) of children whose caregivers belonged to the upper SES had good adherence to HU therapy. However, the association between caregiver's SES and child's adherence to HU therapy was not statistically significant ($\chi^2 = 1.039$, $p = 0.595$). See table VI.

DISCUSSION

The mean age of the children in this study was 10.35 ± 4.34 years, with the majority (46%) aged between 7 and 12 years. This age distribution is consistent with findings from several Nigerian studies on paediatric SCD populations. For instance, a study conducted in Enugu among children attending a tertiary hospital reported a mean age of approximately 9.8 years among SCD patients attending routine clinic follow-up.¹¹ Similarly, a study from Kano in Northern Nigeria also reported that most children with SCD attending paediatric clinics were within the school-age group.¹² This pattern may reflect improved survival of children with SCD due to advances in supportive care and early diagnosis. In the present study, males constituted 54% of the participants, while females accounted for 46%. This finding is similar to reports from other Nigerian studies where a slight male predominance was observed among paediatric SCD cohorts.^{13,14} However, since SCD is inherited as an autosomal recessive disorder, the expected biological distribution between males and females should be approximately equal. Therefore, the slight male predominance observed in this study is likely attributable to sampling variation rather than true gender differences in disease prevalence.

The caregivers in this study had a mean age of 42.9 ± 7.39 years, with half of them aged between 45 and 54 years. Similar caregiver age patterns have been reported in studies conducted in Nigeria and Ghana, where the majority of caregivers of children with chronic illnesses are middle-aged parents, particularly mothers.¹⁵ This reflects the central role played by parents in the long-term care of children with chronic diseases such as SCD. Regarding educational status, 45% of caregivers had secondary education and 34% had tertiary education. This level of educational attainment is comparable with findings from studies conducted in Lagos and Ibadan where most caregivers had at least secondary education.¹⁶ Educational status has been identified as an important determinant of health literacy, treatment adherence, and healthcare utilization among caregivers of children with chronic diseases. Majority of caregivers in this study (77%) had only one child with SCD, while 23% had two children affected. Similar findings have been reported in Nigerian studies which indicate that despite increasing awareness of genotype screening, families may still have more than one child affected with SCD.¹⁷ This highlights the need for strengthened genetic counselling and premarital screening programs to reduce the burden of SCD in Nigeria.¹⁸

The results of this study showed that all caregivers had heard about hydroxyurea therapy for SCD. This high level of awareness may be attributed to regular contact with healthcare professionals in the tertiary hospital setting where the study was conducted. A similar high level of awareness was reported in a study conducted in Lagos, where over 90% of caregivers of children with SCD had heard about hydroxyurea therapy.¹⁹ Despite

the high level of awareness, only 56% of caregivers knew the specific purpose of hydroxyurea therapy. This finding suggests that awareness does not necessarily translate into adequate knowledge. Similar knowledge gaps have been reported in some African studies. For example, a multicentre survey in Nigeria assessing determinants of hydroxyurea utilization found that many caregivers had heard about the drug but lacked adequate understanding of its benefits and indications.¹⁹

Among caregivers who reported knowing the purpose of hydroxyurea therapy, the majority (91.1%) correctly stated that the drug helps prevent or reduce vaso-occlusive crises. This finding aligns with the well-established mechanism of action of hydroxyurea in increasing foetal haemoglobin levels and reducing sickling of red blood cells.¹⁰ Clinical trials and observational studies have demonstrated that hydroxyurea significantly reduces the frequency of painful crises, hospitalizations, and blood transfusion requirements among patients with SCD.²⁰ However, more than half of caregivers (52%) in the present study rated their knowledge of hydroxyurea therapy as poor. Similar findings were reported in a Nigerian study assessing knowledge and prescription patterns of hydroxyurea among healthcare providers and caregivers, which also identified inadequate knowledge as a major barrier to optimal use of the drug.²¹ These findings underscore the need for improved caregiver education programs focusing on hydroxyurea therapy.

All children in this study were currently receiving hydroxyurea therapy, suggesting increasing acceptance and utilization of the drug in the management of SCD. Earlier Nigerian studies had reported lower utilization rates due to concerns about safety, availability, and cost.²² However, in recent years there has been increased advocacy for the use of hydroxyurea as standard therapy for children with SCD. The duration of hydroxyurea therapy among the children in this study varied, with most having used the drug for more than one year. Long-term use of hydroxyurea is recommended because its clinical benefits accumulate over time. Previous studies in Nigeria have also reported that many children remain on hydroxyurea therapy for extended periods with good clinical outcomes.²³ Assessment of adherence in this study showed that 63% of children had not missed any dose in the previous seven days, while overall 58% demonstrated good adherence. This adherence rate is comparable to findings from studies conducted in other African countries. For example, a prospective study in Nigeria evaluating hydroxyurea adherence among children reported adherence rates ranging between 60% and 80% depending on the method of assessment.²⁴ Similarly, a study conducted in Ghana reported moderate adherence levels among paediatric SCD patients receiving hydroxyurea therapy.²⁵ Although 58% of children met the criteria for good adherence, a substantial proportion (42%) demonstrated poor adherence, indicating that adherence remains suboptimal in this setting. The absence of structured reminder systems may contribute to missed doses, as

most caregivers (94%) reported not using reminders. Digital health interventions such as mobile phone reminders have been shown to improve medication adherence in chronic diseases.^{8,9}

One of the most important findings of this study is that the majority of caregivers (72%) reported that hydroxyurea is not always available in hospitals or pharmacies. This suggests that drug availability remains a major barrier to optimal SCD management in Nigeria. The finding that drug availability was frequently reported as inconsistent suggests that health system factors may play a more critical role in adherence than individual socio-demographic characteristics in this setting. Several studies conducted in Nigeria and other African countries have identified limited drug availability as a significant barrier to hydroxyurea therapy. Nnodu et al. reported that inconsistent supply of hydroxyurea and limited access to pharmacies were major challenges faced by patients with SCD in Nigeria.¹⁰ Similar findings have been reported in other sub-Saharan African settings where limited availability of essential medicines affects treatment adherence.²⁶ Cost was identified as a barrier by 28% of caregivers in this study. Although most respondents considered the drug affordable, financial constraints have been widely reported as a major obstacle to hydroxyurea therapy in low- and middle-income countries. In a national survey conducted in Nigeria, over 90% of respondents reported cost as an important barrier to accessing hydroxyurea.¹⁹ The difference between studies may be explained by variations in socioeconomic status or institutional drug subsidy programs. Side effects of hydroxyurea were reported by only 16% of caregivers in this study. The relatively low prevalence of reported adverse effects supports the established safety profile of hydroxyurea in the treatment of SCD. Previous studies have demonstrated that hydroxyurea is generally well tolerated in children, with most side effects being mild and reversible.²⁷

The findings of this study showed that 82% of caregivers observed significant improvement in their children after starting hydroxyurea therapy. This is consistent with evidence from clinical trials and observational studies demonstrating that hydroxyurea significantly reduces disease severity and improves quality of life among patients with SCD.^{10,20} Furthermore, 95% of caregivers reported satisfaction with hydroxyurea therapy, and 89% indicated that they would recommend the drug to other patients. High caregiver satisfaction with hydroxyurea therapy has also been reported in other African studies, reflecting the positive clinical outcomes associated with its use.²⁵ The high level of caregiver satisfaction observed in this study may contribute to improved acceptance of hydroxyurea therapy and encourage continued adherence to treatment.

The present study found no statistically significant association between socio-demographic factors and adherence to hydroxyurea therapy. Variables such as

child's age, gender, caregiver age, educational level, family income, and socioeconomic status were not significantly associated with adherence. Similar findings have been reported in some African studies which suggest that adherence to hydroxyurea therapy is influenced by multiple factors beyond socio-demographic characteristics. For instance, a paediatric study conducted in Nigeria found no significant association between caregiver education, income, or social class and hydroxyurea adherence.²³ However, other studies have reported that higher educational status and socioeconomic status may improve adherence due to better health literacy and improved access to healthcare resources.¹⁶ The absence of statistically significant associations in the present study may be related to the relatively small sample size or the influence of other unmeasured factors. No socio-demographic variable was significantly associated with adherence in this study.

Strengths and Limitations

This study provides useful insight into caregiver knowledge, adherence, and reported barriers to hydroxyurea therapy among children with sickle cell disease in a tertiary hospital in southern Nigeria, a setting where limited data exist. By including both adherence assessment and caregiver perspectives, the study offers a comprehensive overview of factors influencing hydroxyurea use in this population.

However, several limitations should be considered. The cross-sectional design limits the ability to establish causal relationships between assessed factors and adherence. Adherence was measured using caregiver self-report, which may be subject to recall bias or social desirability bias; however, efforts were made to minimize this by assuring participants of confidentiality and conducting interviews in a private setting. The use of convenience sampling may have introduced selection bias and limits the generalizability of the findings beyond the study setting. Additionally, the study was conducted at a single tertiary health facility, which may not fully represent patterns of hydroxyurea use in other regions or levels of care.

CONCLUSION

This study assessed caregiver knowledge, adherence, and reported barriers to hydroxyurea therapy among children with sickle cell disease at a tertiary hospital in Benin City. Although awareness of hydroxyurea was high, important knowledge gaps were identified, and adherence remained suboptimal among a significant proportion of children. Inconsistent drug availability emerged as a frequently reported barrier, suggesting that health system factors may influence sustained medication use. Strengthening caregiver education and ensuring reliable access to hydroxyurea may help

improve adherence and treatment outcomes in this setting.

RECOMMENDATIONS

Given the suboptimal adherence observed in this study, structured caregiver education programs should be strengthened to improve understanding of the purpose and long-term benefits of hydroxyurea therapy. Healthcare providers should reinforce adherence counselling during routine clinic visits and encourage the use of simple reminder strategies to reduce missed doses. In addition, hospital management should prioritize ensuring consistent availability of hydroxyurea to prevent treatment interruptions caused by stock-outs. Addressing these modifiable barriers may enhance sustained adherence and improve clinical outcomes for children with sickle cell disease.

DECLARATIONS

Ethical approval and Consent to participate: Ethical approval was sought and obtained from the Human and Research Ethics Committee of University of Benin Teaching Hospital, Benin City (NHREC-UBTH-HREC/24/12/2022B). The information and consent were given to parents/guardians to read and sign.

Consent for publication: Written informed consent was obtained from all individual participants (or their legal guardians) for publication of this study and its accompanying data.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table I: Socio-demographic characteristics of participants

Variable	Frequency (n = 100)	Percent (%)
Child's age		
1-6 years	22	22.0
7-12 years	46	46.0
13-18 years	32	32.0
Child's Gender		
Male	54	54.0
Female	46	46.0
Caregiver's age		
25-34 years	13	13.0
35-44 years	32	32.0
45-54 years	50	50.0
55-65 years	5	5.0
Caregiver's Gender		
Male	2	2.0
Female	98	98.0
Highest level of education of caregiver		
Primary	21	21.0
Secondary	45	45.0
Tertiary	34	34.0
Number of Children with SCD		
1	77	77.0
2	23	23.0
Family monthly income		
<50,000	6	6.0
50,000-150,000	30	30.0
>150,000	64	64.0
SES		
Upper	28	28.0
Middle	39	39.0
Lower	33	33.0

Table II: Caregivers' knowledge and awareness of hydroxyurea therapy

Variable	Frequency (n = 100)	Percent (%)
Who informed you about hydroxyurea?		
Informed by doctor	98	98.0
Other source	2	2.0
Do you know the purpose of hydroxyurea therapy?		
Yes	56	56.0
No	44	44.0
What is the purpose? (n = 56)		
To prevent/reduce crisis	51	91.1
To raise PCV/build blood	2	3.6
To improve blood flow	2	3.6
To boost immunity	1	1.8
Self-rating of knowledge of hydroxyurea therapy (n = 100)		
Poor	52	52.0
Fair	39	39.0
Good	9	9.0

Table III: Children's adherence to Hydroxyurea therapy

Variable	Frequency (n = 100)	Percent (%)
Is your child currently taking HU?		
Yes	100	100.0
No	0	0.0
How long has the child been taking HU?		
<6 months	15	15.0
6-12 months	19	19.0
1-3 years	36	36.0
>3 years	30	30.0
How often is your child supposed to take HU?		
Twice daily	86	86.0
Daily	14	14.0
In the last 7 days, how many doses of HU did your child miss?		
None	63	63.0
1-6 doses	26	26.0
7-14 doses	11	11.0
In the last one month, how many doses were missed?		
None	5	5.0
1-4 doses	69	69.0
5-14 doses	18	18.0
15-60 doses	8	8.0
What is the main reason for missed doses?		
Forgot	11	11.0
Ran out of medicine	28	28.0
Child refusal	7	7.0
Fear of infertility as side effect	1	1.0
Could no longer afford the cost	1	1.0
Felt drugs were too much for her	1	1.0
No reason	51	51.0
Do you use reminders for giving the drug?		
Yes	6	6.0
No	94	94.0
Do you attend regular follow-up clinic visits?	(n = 100)	
Yes	83	83.0
No	17	17.0
Adherence*		
Poor adherence	42	42.0
Good adherence	58	58.0

Good adherence was defined as missing ≤ 1 dose in the previous 7 days and ≤ 4 doses in the previous one month.

Table IV: Caregiver-reported barriers to hydroxyurea therapy

Variable	Frequency (n = 100)	Percent (%)
Is HU always available in your hospital/pharmacy?		
Yes	28	28.0
No	72	72.0
Is the cost of HU affordable to your family?		
Yes	72	72.0
No	28	28.0
Have you noticed any side effects of HU in your child?		
Yes	16	16.0
No	84	84.0

Which side effects?	(n = 16)	
could not say	13	81.3
Abdominal discomfort	1	6.3
Crises after intake	1	6.3
PCV still low	1	6.3
Do you have challenges remembering daily doses?		
Yes	6	6.0
No	94	94.0
Does your child resist taking the drug?		
Yes	24	24.0
No	76	76.0
Do you feel you have enough support from health workers regarding HU use?		
Yes	90	90.0
No	10	10.0

Table V: Caregivers perceived benefits and satisfaction with HU therapy.

Variable	Frequency (n = 100)	Percent (%)
Have you noticed any improvement in your child after starting HU?		
Significant improvement	82	82.0
Slight improvement	13	13.0
No improvement	2	2.0
Not sure	3	3.0
Are you satisfied with HU therapy for your child?		
Yes	95	95.0
No	5	5.0
Would you recommend HU therapy for other patients?		
Yes	89	89.0
No	11	11.0

Table VI: Association between socio-demographic factors and adherence to HU therapy

Variable	Adherence to HU therapy		χ^2	P-value
	Poor adherence	Good adherence		
Age of child				
1-6 years	9 (45.0%)	11 (55.0%)	2.522	0.282
7-12 years	16 (34.0%)	31 (66.0%)		
13-18 years	17 (51.5%)	16 (48.5%)		
Gender of child				
Male	22 (40.7%)	32 (59.3%)	0.076	0.840
Female	20 (43.5%)	26 (56.5%)		
Age of caregiver				
25-34 years	7 (58.3%)	5 (41.7%)	2.392	0.302
35-44 years	11 (33.3%)	22 (66.7%)		
45-65 years	24 (43.6%)	31 (56.4%)		
Caregivers' HLE				
Primary	11 (52.4%)	10 (47.6%)	1.369	0.504
Secondary	19 (41.3%)	27 (58.7%)		
Tertiary	12 (36.4%)	21 (63.6%)		
Number of children with SCD				
1	34 (45.3%)	41 (54.7%)	1.368	0.350
2	8 (32.0%)	17 (68.0%)		

Know purpose of HU therapy for SCD children				
Knows	21 (37.5%)	35 (62.5%)	1.058	0.317
Don't know	21 (47.7%)	23 (52.3%)		
Family monthly income				