Original Article

Burden, Clinical Spectrum, Predictors of Severe Anaemia, and In-hospital Outcomes of Pediatric Severe Malaria: A Retrospective study from a Tertiary Hospital Cohort

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ABSTRACT

Severe malaria (SM) remains a leading cause of childhood morbidity and mortality in Nigeria, with severe malarial anaemia (SMA) driving transfusion demand and poor outcomes. Recent contemporary hospital-based data from Southwestern Nigeria are limited. This study described the burden, clinical spectrum, predictors of severe anaemia, and in-hospital outcomes of paediatric SM at a tertiary hospital in Southwest Nigeria. We retrospectively reviewed case records of children aged 1 month–14 years admitted with SM to Olabisi Onabanjo University Teaching Hospital, between January–December 2023. Demographic, clinical, laboratory, treatment, and outcome data were extracted while predictors of SMA were assessed using logistic regression. Of 699 paediatric admissions, 65 (9.3%) were confirmed SM cases; 55.4% were <5 years, and 72.3% males. Nearly two-thirds were underweight, and 89% belonged to low-middle socioeconomic classes. The most frequent WHO severity criteria were multiple convulsions (35.4%), prostration (33.8%), cerebral malaria (16.9%), and SMA (16.9%). Eleven children developed SMA; with pallor as a presenting complaint being the strongest independent predictor (adjusted OR 8.94, 95% CI 1.60–49.8, p=0.012). All patients received intravenous artesunate, and 87.5% received empiric antibiotics. Median hospital stay was 6 days (IQR 3.5–9.5). Overall survival was 96.9%, with 2 deaths (3.1%). However, 18.5% were discharged against medical advice. Conclusively, severe malaria accounted for nearly one-tenth of paediatric admissions, predominantly affecting under-fives and socioeconomically disadvantaged children. Pallor strongly predicted SMA, underscoring its bedside triage value. High survival with artesunate contrasts with high discharged-against-medical-advice rates, highlighting the need for caregiver support and financial protection.

Keywords: Clinical Spectrum, Outcome, Paediatric Severe Malaria, Severe Malaria Anaemia, Predictors, Tertiary Hospital Cohort.

INTRODUCTION

Malaria remains a major public health challenge in sub-Saharan Africa, disproportionately affecting children under five years of age. In 2023, an estimated 263 million cases and 597,000 malaria-related deaths occurred globally, with the World Health Organization (WHO) African Region accounting for approximately 94% of cases and 95% of deaths.[1] Nigeria alone contributes about 26% of global malaria cases and nearly 31% of malaria deaths, with young children bearing the greatest burden.[12] Despite expanded vector control, chemoprevention, and improved case management, malaria-related morbidity and mortality remain unacceptably high in Nigerian children.[1]

Severe malaria (SM), predominantly caused by *Plasmodium falciparum*, represents the most life-threatening spectrum of infection. The WHO criteria include impaired consciousness, metabolic acidosis, hypoglycaemia, acute kidney injury, hyperparasitaemia, and severe malarial anaemia (SMA), defined in children as haemoglobin <5 g/dL or haematocrit <15%.[3,4] Severe malaria anaemia is particularly common in high-transmission settings and is a major driver of paediatric transfusion demand.[3,5] Although timely blood transfusion significantly reduces mortality when haemoglobin falls below 5 g/dL, survival gains are often limited by blood shortages, delayed cross-matching, and constrained critical-care capacity in resource-limited hospitals.[5]

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Hospital-based studies across Nigeria report case fatality rates (CFRs) for severe paediatric malaria ranging from 4–10%, with outcomes influenced by complication type, comorbidities, and timeliness of care.[6-8] Predictors of SMA identified in some northern cohorts are age less than 5 years, fever and high parasite density.[8] However, regional variability exists, and contemporary data from Southwestern Nigeria remain limited.

Given Nigeria's disproportionate contribution to the global malaria burden and persistent health-system constraints, updated hospital-level evidence is needed to quantify the current burden and outcomes of paediatric severe malaria and SMA. We hypothesized that SMA remains a predominant complication of severe malaria in children and that specific clinical parameters predict its occurrence. This study aimed to describe the demographic and clinical characteristics of childhood severe malaria admissions at a tertiary centre in Southwestern Nigeria; determine the prevalence and predictors of SMA; and assess treatment patterns and in-hospital outcomes.

MATERIALS AND METHODS

This was a one-year retrospective descriptive cross-sectional study conducted at Olabisi Onabanjo University Teaching Hospital (OOUTH), Ogun State, Nigeria. The teaching hospital serves as a referral center for many Local Government Areas in Ogun State and receives a high volume of paediatric severe malaria cases. All children aged 1 month to 14 years admitted for severe malaria between January 2023 and December 2023 were eligible for inclusion.

The inclusion criteria were cases with clinical diagnosis of severe malaria supported by a positive rapid diagnostic test (RDT) for *Plasmodium falciparum,* and availability of medical records including demographic data, presenting complaints, laboratory findings, treatment, and outcomes for the cases. Children who were managed for severe malaria but with no documented evidence for malarial parasitaemia (either by MP or RDT) or with significantly incomplete data record were excluded.

Data Collection

Data were extracted from hospital admission records and patient charts using a pre-structured checklist. Collected variables included demographics: age, sex, settlement; Oyedeji's socioeconomic indicators: parental occupation and level of education; clinical data: presenting complaints, nutritional status, severity criteria (based on WHO definitions); packed cell volume (PCV), full blood count (FBC), malaria RDT; use of intravenous artesunate or other antimalarials; use of antibiotics; and duration of hospital stay, discharge status, complications, or death.[9]

Definitions

Severe malaria was defined according to WHO criteria as presence of malaria parasitaemia with life threatening complications (e.g. severe anaemia, prostration, hypoglycaemia, haemoglobinuria, acute kidney injury, altered consciousness, cerebral malaria, multiple convulsions, respiratory distress).[4] Also, undernutrition (underweight) was defined using weight-for-age Z-scores below −2 standard deviations (SD) from the median of the WHO Child Growth Standards, with severe underweight defined as <−3 SD.[10]

Data Analysis

Data were analysed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize patient characteristics and outcomes. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using means and standard deviations or medians and interquartile ranges (IQRs) as appropriate. Chi-square tests were used to explore associations between clinical variables and outcomes. Univariate and multivariate logistic regression analysis were done to determine predictors of severe anaemia. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee (HREC) of OOUTH, Sagamu (Protocol No: OOUTH/HREC/840/2024AP). All data were anonymized to protect patient confidentiality.

RESULTS

A total of 699 children were admitted to the pediatric wards during the study period. Of these, 75 children were diagnosed with severe malaria. However, only 65 children had positive pfRDT or malaria parasite smear positive results, leaving the prevalence at 9.3%. Of the 65 children with confirmed cases of severe malaria, 36 (55.4%) were aged below 5 years. There was a marked male predominance, with 47 (72.3%) males and 18 (27.7%) females, giving a male to female ratio of 2.6:1. The majority of patients, 46 (70.8%) resided in urban areas, and most of the mothers (49.2%) had secondary education, while 14.3% had no formal education. Nearly 90% of the children came from low (45.3%) and middle (43.8%) socioeconomic classes, Table I.

Nutritional assessments indicated varying degrees of malnutrition among the cohort (Figure 1). The weight of three of the children was not available in the record file. Close to two-thirds of the children were underweight, with 9 (14.5%) being severely underweight. Figure 2 shows the symptoms of malaria while Figure 3 shows the various severity criteria documented, based on the WHO criteria. The most common symptoms at presentation included fever, convulsions, vomiting and paleness of the body; with fever being a constant presenting complaint (100%) for all the cases. Using the WHO criteria, several children met more than one severity criterion such as prostration, impaired consciousness, multiple convulsions, and severe anemia. Multiple convulsions, prostration, cerebral malaria and severe anaemia were the leading severity criteria among the cohort, with 35.4%, 33.8%, 16.9% and 16.9% respectively. Two or more severity criteria were seen in 33.8% of the cases. Of the severe anaemia cases, 5 (45.5%) co-existed with other complications.

All 65 children (100%) tested positive for malaria using the rapid diagnostic test (pfRDT). The mean packed cell volume (PCV) was 26.8% ± 13.2, with a wide range of 6.9% to 41.9%, indicating moderate to severe anemia in some patients. There were 11 (16.9%) cases of severe anamia, defined by packed cell volume <15%. All the patients received intravenous artesunate, followed by artemisinin-based combination therapy. Additionally, 56 (87.5%) received intravenous antibiotics, while 8 (12.5%)

were managed without antibiotics. All the children with severe anaemia received blood transfusion. The median duration of hospitalization was 6 days (IQR: 3.5–9.5), with a mean duration of 7.58 ± 6.22 days. In-hospital outcomes were favorable in most of the cases, with 63 children (96.9%) surviving and 2 deaths (3.1%) recorded, 1 each from cerebral malaria and multiple convulsions, Table II. Notably is also the high rate of discharge against medical advice (DAMA) in the records (18.5%). Table III shows the association between the sociodemographic characteristics of the children managed, their presenting complaints and other severity criteria of malaria, with severe malaria anaemia. Regarding the sociodemographic characteristics, settlement type was significantly associated with severe anaemia ($\chi^2 = 8.000$, $p = 0.018$), with cases occurring more frequently among children from semi-urban (60.0%, 3 out of 5 children) and rural areas (21.4%, 3 out of 14 children) compared to urban areas (10.9%, 5 out of 46 children). There was no significant association between other sociodemographic variables and SMA. With respect to presenting complaints, severe anaemia was significantly associated with convulsions ($\chi^2 = 4.680$, $p = 0.031$), pallor ($\chi^2 = 12.188$, $p < 0.001$), and yellowness of the eyes (jaundice) ($\chi^2 = 4.670$, $p = 0.031$). Other symptoms, including vomiting, diarrhoea, cough, headache, abdominal pain, and loss of consciousness, showed no significant relationship with severe anaemia. Among the other WHO severity criteria documented, only passage of dark urine (haemoglobinuria) showed a significant association with severe anaemia ($\chi^2 = 4.670$, $p = 0.031$). On univariate logistic regression, the presence of pallor (OR = 15.00, 95% CI: 3.14–77.66, $p < 0.001$), jaundice (OR = 7.14, 95% CI: 1.45–35.23, $p = 0.016$), and passage of dark urine (OR = 7.14, 95% CI: 1.45–35.23, $p = 0.016$) were significant predictors of severe anaemia, Table IV. In the multivariate model, only pallor remained an independent predictor of severe anaemia (adjusted OR = 8.94, 95% CI: 1.60–49.78, $p = 0.012$), Table IV. Jaundice, passage of dark urine, and convulsions were not independently associated after adjustment.

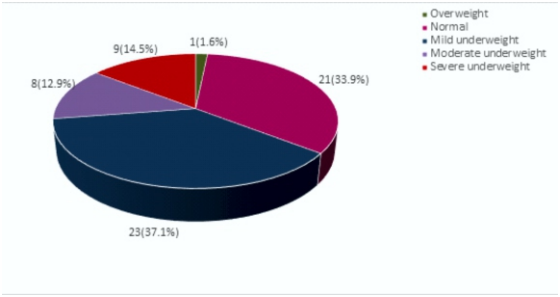

Figure 1: Nutritional status of children with severe malaria

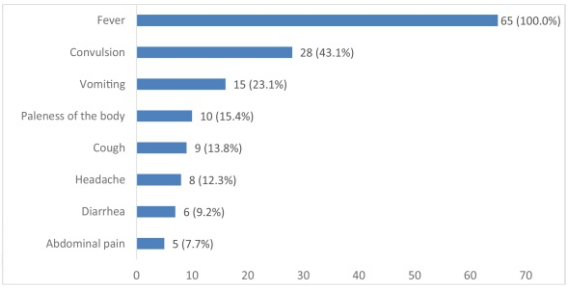

Figure 2: Symptoms of malaria at presentation.

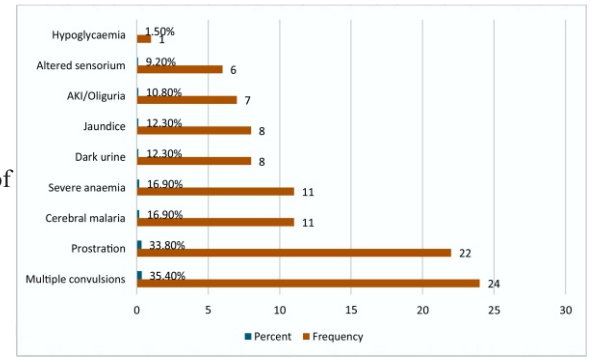

Figure 3: WHO severity criteria seen.

Table 1: Socio-demographic variables of the children

Variable	Frequency, n=65	Percent (%)
Age (years)		
< 5	36	55.4
. .	29	44.6
Sex		
Male	47	72.3
Female	18	27.7
Settlement		
Rural	14	21.5
Semi-Urban	5	7.7
Urban	46	70.8
Mother's level of education		
No formal education	10	14.3
Primary	10	15.9
Secondary	32	49.2
Tertiary	13	20.6
Mother's occupation		
Civil servant	9	13.8
Trading	23	35.4
Farming	10	15.4
Artisan	2	3.1
Clergy	2	3.1
Unemployed	19	29.2
Socioeconomic class		
Upper	7	10.9
Middle	29	43.8
Lower	29	45.3

Table 2: Investigations, treatment and outcomes

Variable	Frequency	Percent (%)
pfRDT	65	100
Packed cell volume (%)		
Mean ± SD	26.82 ± 13.17	
Median (IQR)	27.75 (17.85 – 33.28)	
Range	6.9– 41.9	
IV Artesunate		
Yes	65	100.0
IV Antibiotics		
Yes	56	87.5
No	8	12.5
Duration of stay		
Median (IQR)	6.00 (3.50 – 9.50)	
Mean ± SD	7.58 ± 6.22	
Outcome		
Discharged	50	76.9
Died	2	3.1
Discharged against medical advice	12	18.5
Referred	1	1.5

IQR: Interquartile Range, SD: Standard Deviation.

Table 3: Association between sociodemographic characteristics, presenting complaints and other severity criteria of malaria, with severe anaemia.

Parameters		Severe anaemia		χ^2	p value
		Yes n (%)	No n (%)		
Sociodemographic characteristics					
Age-	<5years	8(22.2)	28(77.8)	0.878[Y]	0.349
	≥5years	3(10.3)	26(89.7)		
Sex-	Male	8(17.0)	39(83.0)	0.113[Y]	0.737
	Female	3(16.7)	15(83.3)		
Settlements-	Rural	3(21.4)	11(78.6)	8.000	**0.018***
	Semi-urban	3(60)	2(40)		
	Urban	5(10.9)	41(89.1)		
Socioeconomic class-	Upper	1(14.3)	6(85.7)	1.209[Y]	0.546
	Middle	3(10.3)	26(89.7)		
	Lower	7(24.1)	22(75.9)		
Nutritional status-	Overweight	0(0.0)	1(100.0)	0.527	0.768
	Normal	3(14.3)	18(85.7)		
(Mild-severe)	Underweight	8(20.0)	32(80.0)		
Presenting complaints					
Vomiting	Yes	3(18.8)	13(81.3)	0.025[Y]	0.874
	No	8(16.3)	41(83.7)		
Diarrhoea	Yes	0(0.0)	7(100.0)	0.534[Y]	0.465
	No	11(19.0)	47(81)		
Cough	Yes	**0(0.0)**	**9(100.0)**	**0.960**[Y]	**0.327**
	No	11(19.6)	45(80.4)		
Headache	Yes	0(0.0)	8(100.0)	0.739[Y]	0.390
	No	11(19.3)	46(80.7)		
Loss of consciousness-	Yes	1(11.1)	8(88.9)	0.000[Y]	1.000
	No	10(17.9)	46(82.1)		
Convulsion	Yes	1(3.6)	27(96.4)	4.680[Y]	**0.031***
	No	10(27.0)	27(73.0)		
Paleness of body	Yes	6(60.0)	4(40.0)	12.188[Y]	**<0.001***
	No	5(9.1)	50(90.9)		
Jaundice	Yes	4(50.0)	4(50.0)	4.670[Y]	**0.031***
	No	7(12.3)	50(87.7)		
Abdominal pain-	Yes	1(20.0)	4(80.0)	0.036[Y]	0.850
	No	10(16.7)	50(83.3)		
Other WHO severity criteria					
Altered sensorium-	Yes	0(0.0)	6(100.0)	0.347[Y]	0.556
	No	11(18.6)	48(81.4)		
Prostration-	Yes	1(4.5)	21(95.5)	2.415[Y]	0.120
	No	10(23.3)	33(76.7)		
Passage of dark urine	Yes	4(50.0)	4(50.0)	4.670[Y]	**0.031***
	No	7(12.3)	50(87.7)		
Hypoglycaemia	Yes	0(0.0)	1(100.0)	0.207	0.649
	No	11(17.2)	53(82.8)		
Acute kidney injury-	Yes	1(14.3)	6(85.7)	0.113[Y]	0.737
	No	10(17.5)	47(82.5)		
Cerebral malaria-	Yes	1(9.1)	10(90.9)	0.102[Y]	0.749
	No	10(18.5)	44(81.5)		
Multiple convulsions-	Yes	1(4.2)	23(95.8)	3.083[Y]	0.079
	No	10(24.4)	31(75.6)		

NB: Column total of severe anaemia (yes) is 11,and (no) is 54, except for nutritional status (51) where weights of 3 patients were missing; *is significant (p<0.005); Y is Yates' correction.

Table 4: Binary logistic regression analysis for predictors of severe anaemia.

Univariate analysis						
variables	**B**	**Wald**	**p value**	**Exp (B)**	**95% CI**	
					Lower	**Upper**
Settlement	0.491	1.797	0.180	1.634	0.797	3.350
Constant	0.423	0.223	0.637	1.526		
Paleness of body	2.708	11.519	**<0.001***	15.000	3.140	77.660
Constant	-3.114	5.138	0.023	0.044		
Convulsion	-2.303	4.516	**0.034***	0.100	0.012	0.836
Constant	5.598	7.314	0.007	270.000		
Jaundice	1.966	5.832	**0.016***	7.143	1.448	35.228
Constant	-1.966	1.787	0.181	0.140		
Dark urine	1.966	5.832	**0.016***	7.143	1.448	35.228
Constant	-1.966	1.787	0.181	0.140		
Multivariate analysis						
Paleness of body	2.190	6.245	**0.012***	8.935	1.604	49.781
Convulsion	-1.451	1.567	0.211	0.234	0.024	2.273
Jaundice	1.008	1.078	0.350	2.740	0.331	22.659
Dark urine	1.008	1.078	0.350	2.740	0.331	22.659
Constant	-3.361	0.771	0.380	0.035		

B: Beta co-efficient; Exp (B): Exponentiated Beta co-efficient, CI: Confidence interval

DISCUSSION

In this study, severe malaria accounted for 9.3% of pediatric admissions in the year 2023, underscoring a substantial burden within tertiary care settings. This finding is comparable to a tertiary facility-based study in North-central Nigeria where a prevalence of 9.9% was reported for the year 2022.[11] A prevalence of 8.4% was also reported in Northeast Nigeria for a five-year retrospective survey between 2014 and 2018, a little lower than the finding in the current study.[12] The slight regional variations (lower in the Northeast, higher in the Southwest, intermediate in the North-central) highlight the role of geographic, environmental, and health-system differences in shaping malaria epidemiology.

We found that more than half of the children with severe malaria in this study were under-five, a pattern consistent with global epidemiology where under-five children bear a disproportionate share of morbidity and mortality due to malaria.[13] A hospital-based study also found that more than two-thirds of children with severe malaria were under five, reinforcing age as a critical risk factor.[14] The concentration of severe cases in this age group likely reflects waning maternal immunity, lack of acquired protection, higher parasite replication rates, cytoadherence, and inflammatory responses. Nearly 90% of our cohort belonged to low and middle socioeconomic status (SES) groups, similar to the finding by Nwaneli et al [15] in Southeast, Nigeria. Lower SES is a well-documented driver of malaria susceptibility, stemming from inadequate housing, poor nutrition, limited educational attainment, and lower access to preventive measures like insecticide-treated nets (ITNs).[16,17] Close to two-thirds of the children were underweight, with 14.5% being severely underweight. Malnutrition is a well-established driver of poor malaria outcomes and anaemia, identified across multiple African settings.[18] Although malnutrition was not identified as a significant predictor in our models, its prevalence suggests that it may still exert indirect effects on disease severity and recovery.

In this cohort, fever was universal at presentation, with convulsions, vomiting and clinically apparent pallor among the leading symptoms; by WHO severity criteria, the most frequent features were multiple convulsions, prostration, cerebral malaria and severe anaemia. These patterns mirror contemporary descriptions of pediatric severe malaria in sub-Saharan Africa, where neurological involvement and SMA dominate the clinical picture. [19,20] Besides, one-third of the cases had multiple complications at presentation, aligning with the spectrum reported in the Uganda study. [20] Clinically apparent pallor was strongly associated with SMA on both bivariate analysis and in the multivariable model, which is consistent with the central role of haemolysis and dyserythropoiesis in pediatric falciparum malaria pathophysiology and with prior summaries listing SMA as a leading complication in high-transmission settings.[21] A child with paleness or pallor as a presenting complaint by the mother has about nine times likelihood of having SMA according to this study. In many communities, caregivers rarely identify or act upon subtle pallor in their children. Thus, when pallor is reported at the point of care, it often represents a more advanced stage of anaemia. This underscores the importance of caregiver education on early recognition of anaemia and the need for prompt presentation to health facilities before progression to severe complications, especially congestive heart failure.

Our finding that jaundice and haemoglobinuria were significantly associated with severe anaemia on bivariate

analysis but lost significance in multivariable modeling is epidemiologically plausible. Both clinical features are markers of intravascular haemolysis and therefore correlate strongly with low haemoglobin levels. However, when more direct and visually reliable indicators of anaemia such as pallor are included in the model, the additional predictive contribution of jaundice and haemoglobinuria diminishes. In essence, these haemolysis-related signs reflect the same underlying pathophysiological process but do not independently improve prediction once pallor is taken into account. Similar findings were obtained by other authors where pallor was reported to have predicted severe anaemia following malaria infection, even after a multivariate regression analysis.[22,23] Ajetumobi *et al*[24] and Conroy *et al*[25] also reported that haemoglobinuria was a prominent feature of severe malaria and associated with jaundice, reflecting intravascular haemolysis, but the studies did not show it as an independent predictor of anaemia severity after accounting for other factors.

All children received intravenous artesunate with step-down to artemisinin-based combination therapy (ACT); this is guideline-concordant care and likely contributed to the low in-hospital case fatality observed here. Comparable mortality rate (1.5-4.2%) has been reported in recent Nigerian and regional series where artesunate coverage was high, and supportive measures such as timely blood transfusion and critical care for complications, were available. Our outcome therefore aligns with the improving survival trend where timely artesunate and supportive care are reliably delivered. Empiric intravenous antibiotics were administered to over eighty percent of patients of the current cohort. While this proportion is high, it reflects current realities: distinguishing severe malaria from invasive bacterial infection at presentation may be difficult. The WHO and expert reviews recommend concomitant broad-spectrum antibiotics when meningitis, aspiration, or sepsis cannot be confidently excluded. [4,26] Clinicians should however balance early coverage against antimicrobial stewardship, ideally de-escalating once bacterial sepsis is excluded.

The median length of stay (LOS) was 6 days, slightly longer than the 3–5 days reported in several recent African cohorts, including multicenter analyses of severe febrile illness and post-discharge trajectories. [27] Differences may reflect higher baseline severity (multiple qualifying criteria per child), delayed presentation, greater use of parenteral antibiotics, or socio-logistical barriers to early discharge (e.g., transfusion delays for SMA, caregiver severe financial constraints cum inability to replace donated blood and pay bills on time). The longer LOS in our setting may also relate to the co-occurrence of neurological features and anaemia in some cases, each of which can slow clinical stabilization and readiness for discharge.

A notable and concerning outcome was the high rate of discharge against medical advice (DAMA). Contemporary Nigerian pediatric literature generally reports smaller DAMA proportions, with financial constraints, perceived recovery, and preference for traditional care commonly cited.[28] Our higher DAMA rate may reflect the economic burden of prolonged admissions, out-of-pocket expenditures for supportive therapies (e.g., blood, antibiotics, imaging), and caregiver responsibilities that limit hospital stay. Targeted social and financial risk protection (health insurance uptake, social workers support, early counseling on complications and expected LOS) could mitigate DAMA and potential post-discharge mortality, which remains a recognized hazard after severe malaria.[27]

CONCLUSION

Severe malaria remains a significant cause of pediatric morbidity in our setting, accounting for nearly one-tenth of pediatric admissions in 2023. The burden was disproportionately borne by children under five years of age and those from lower socioeconomic backgrounds, highlighting persistent vulnerabilities linked to age, poverty, and limited access to preventive measures. Clinically, severe anaemia and neurological manifestations were the predominant complications, with pallor emerging as a strong independent clinical predictor of severe malarial anaemia. This emphasizes the importance of careful clinical assessment and improved caregiver awareness for early recognition of anaemia in children with febrile illness.

The findings also demonstrate that adherence to recommended treatment protocols, particularly the use of intravenous artesunate alongside appropriate supportive care such as blood transfusion when indicated, was associated with a low in-hospital case fatality rate. However, the relatively longer hospital stay and the high rate of discharge against medical advice underscore ongoing socioeconomic and health-system challenges that may compromise optimal outcomes.

RECOMMENDATIONS

Strengthening malaria prevention strategies, particularly among under-five children and those from lower socioeconomic households, remains essential. Increased caregiver education on early symptoms of malaria and recognition of warning signs such as pallor should be promoted to encourage prompt health-seeking behavior. Health facilities should maintain adherence to guideline-recommended management of severe malaria, including early administration of intravenous artesunate and timely supportive care such as blood transfusion for severe anaemia. In addition, policies that reduce out-of-pocket healthcare costs and improve financial support for hospitalized children may help reduce discharge against medical advice and improve treatment outcomes.

STRENGTH AND LIMITATION OF THE STUDY

This study provides recent hospital-based data on the clinical spectrum and outcomes of severe malaria in Southwestern Nigerian children, using standardized WHO severity criteria. The findings also add value by examining predictors of SMA, an underexplored complication in local literature. However, the study has limitations. Its retrospective design relied on hospital records, which may have been incomplete or inconsistently documented. Being single-centered, and with a relatively small number of children with severe anaemia, the generalizability and statistical robustness are limited.

Conflict of interest

We declare no conflict of interest..

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