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Review Article

Severe Malaria in Children in Rural African Settings

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Abstract

Introduction: Severe malaria remains a major public health concern in sub-Saharan Africa, particularly affecting children. Healthcare facilities in rural African settings serve populations that are often very vulnerable and at high risk of malaria. Our objective was to study the epidemiological, clinical, paraclinical, and therapeutic aspects of severe malaria.

Methodology: This was a retrospective, descriptive and analytical study based on hospital records. Statistical analyses were performed using SPSS software.

Results: The prevalence of severe malaria was 4.06% among hospitalized pediatric patients, representing 58.1% of all pediatric malaria cases. Children aged 1 to 4 years (53.4%) and boys (59.9%) were the most affected. Fever (96.1%) and seizures (51.8%) dominated the clinical presentation, with repeated seizures being the main severity criterion (52.4%). Anemia (96.7%), often associated with thrombocytopenia (55%), was almost constant. Treatment with artesunate (100%) resulted in recovery in 97.1% of cases, with a mortality rate of 2.3%. Young age was significantly associated with poor outcomes.

Conclusion: This study demonstrates the effectiveness of protocol-based management of severe pediatric malaria in rural African settings. However, the disease remains highly prevalent in these areas, with significant morbidity and mortality.

Keywords: Severe Malaria; Children; Hospital; Rural Setting

Introduction

Malaria remains a major global public health challenge, with a particularly devastating impact in sub-Saharan Africa, where it disproportionately affects children under five years of age [1]. In 2023, the African region accounted for 94% of malaria cases (246 million) and 95% of malaria-related deaths (569,000), with children under five representing approximately 76% of these deaths [1]. *Plasmodium falciparum*, responsible for severe forms, is predominant in sub-Saharan Africa, where a child dies of malaria every two minutes [2]. In Senegal, despite efforts to control and eliminate malaria, the disease remains a major public health concern [3]. In 2019, malaria was the leading cause of outpatient visits and hospitalizations in the country's health facilities [3]. Regional disparities persist, with remote rural areas accounting for a significant proportion of cases [4]. In these areas, malaria remains endemic and poses a major challenge due to limited access to healthcare and high disease prevalence. In recent years, health services in Africa have played a crucial role in the management of children with severe malaria. Following the implementation of several measures, including Seasonal Malaria Chemoprevention (SMC), it is important to analyze how malaria cases evolve in rural settings. The overall objective was to study the epidemiological, clinical, paraclinical, and prognostic aspects of severe malaria among vulnerable hospitalized children living in rural areas.

Methodology

Study setting

The study was conducted in a level-3 health facility located in the extreme southeast of Senegal (West Africa), 700 km from the capital (Dakar). The area has a population of 172,482 inhabitants, mostly young, with diverse nationalities (Malian, Guinean, Senegalese, etc.). The pediatric department manages children aged 0 to 15 years and has been functional since November 2021.

Study type, period, and population

This was a retrospective, descriptive, and analytical study conducted from May 2021 to December 2023. All children aged 0 to 15 years hospitalized for severe malaria were included. The diagnosis of severe malaria was based on a positive thick blood smear in a patient presenting one or more WHO-defined severity criteria, or a positive rapid diagnostic test for *Plasmodium falciparum* in a patient who had not received antimalarial treatment and presented one or more WHO-defined severity signs.

Variables studied

Data were collected from hospital records using a structured data sheet:

- **Sociodemographic variables:** Age, sex, nationality, geographic origin.
- **Clinical data:** Main reasons for consultation/referral, medical history, vital signs, severity criteria (altered consciousness, hemoglobinuria, abnormal bleeding, acute pulmonary edema, severe anemia, renal failure, hypoglycemia, hyperparasitemia, jaundice, repeated seizures, shock, prostration, metabolic acidosis).
- **Paraclinical data:** Parasitological confirmation tests (RDT, thick smear), hemoglobin level, hematocrit, MCV, MCHC, MCH, white blood cell and platelet counts, blood group and Rh factor.
- **Therapeutic data:** Symptomatic treatment (analgesics/antipyretics, antiemetics, anticonvulsants, anti-anemic drugs, blood transfusion), etiological treatment (artesunate, artemether, quinine), treatment duration, hospitalization duration.
- **Hospital course:** Recovery, discharge against medical advice, transfer, death.

Data analysis

Data were entered using Microsoft Excel 2019 and analyzed with SPSS version 2.5.

Descriptive analysis presented quantitative variables as means, standard deviations, medians, and interquartile ranges depending on their distribution. Qualitative variables were expressed as counts and percentages. For comparing qualitative variables, the Chi-square test was used with a significance threshold of $p < 0.05$ and a 95% confidence interval.

Ethical considerations

The study was conducted in strict compliance with ethical principles of medical research. Official authorization was obtained from the institution's management. All collected data were fully anonymized to ensure participant confidentiality.

Results

Frequencies

We identified 307 patients diagnosed with severe malaria out of 7,556 hospitalized patients (all diagnoses included), corresponding to a hospital frequency of 40.6‰ for severe malaria in children. Among all malaria cases (522), severe malaria predominated with 307 cases (58.11%), compared to 215 cases (41.19%) of uncomplicated malaria.

Sociodemographic characteristics

Age distribution

The 1–4-year age group was the most affected, with 164/307 cases (53.4%), followed by children aged 5–9 years with 90/307 cases (29.4%) (Figure 1).

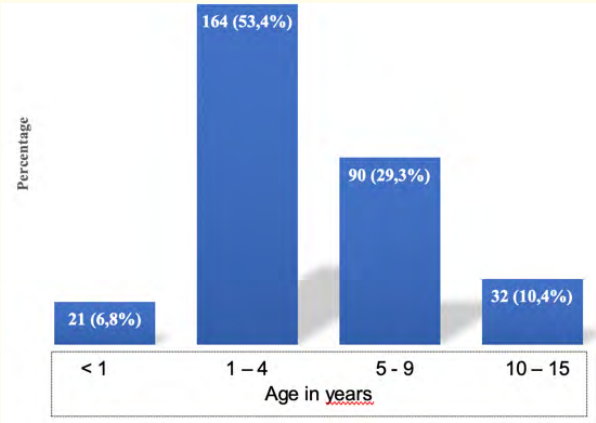

Figure 1: Distribution of Severe Malaria Cases by Age.

Distribution by sex

A male predominance was observed, with 184 boys and 123 girls, corresponding to a male-to-female sex ratio of 1.5.

Distribution by geographic origin

A total of 251 cases (81.6%) were Senegalese children, followed by Guineans with 29 cases (9.4%), Malians with 2 cases (0.7%), while 25 cases (8.1%) had no information reported.

Clinical characteristics

Time to consultation

The mean time to consultation was 2.71 ± 1.33 days, with a minimum of 1 day and a maximum of 14 days. A total of 263 patients (68.3%) consulted within 1 to 3 days, while 118 patients (30.7%) consulted after more than 3 days.

Reasons and mode of admission

More than 99% of children were referred from another facility.

Admissions for severe malaria represented 76% (n = 289) of transfer reasons, followed by fever 15.4% (n = 49), seizures 5% (n = 16), anemia 3.6% (n = 11), and altered consciousness 1.6% (n = 5).

Vital signs

- Fever was present in 291 children (94.8%).
- Hyperglycemia affected 164 children (53.4%), while hypoglycemia was found in 5.6% (n = 17).
- Tachypnea was observed in 81 children (26.4%), and 25 cases (8%) had hypoxia.

Functional Symptoms

Seizures were the most frequent presenting symptom, occurring in 52% (n = 159) of cases.

They were followed by:

- Vomiting: 43% (n = 134)
- Headache: 19% (n = 58)
- Diarrhea: 13% (n = 40)
- Abdominal pain: 10.7% (n = 33)

Other functional manifestations included dyspnea, cough, dizziness, and generalized body pains.

Distribution According to Severity Criteria

Seizures were the most common severity criterion, found in 161/307 cases (52.4%).

Prostration affected 122/307 children (39.7%). Altered consciousness was noted in 82/307 cases (26.7%). Severe anemia was present in 47/307 children (15.3%) (Table I).

Severity Criteria	Frequency	Percentage (%)
Repeated seizures	161	52,4
Prostration	122	39,7
Impaired consciousness	82	26,7
Severe Anemia	47	15,3
High Parasitemia	34	11,1
Jaundice	12	3,9
Acute Kidney injury	8	2,6
Hypoglycemia	5	1,6

Table I: Distribution according to severity criteria observed in children.

Paraclinical data

Malaria test results

The rapid diagnostic test (RDT) was performed in all patients and was positive in every case. Thick blood smear analysis was performed in 47.6% of patients, and parasitemia was moderately elevated in 22.1% of cases (Figure 2).

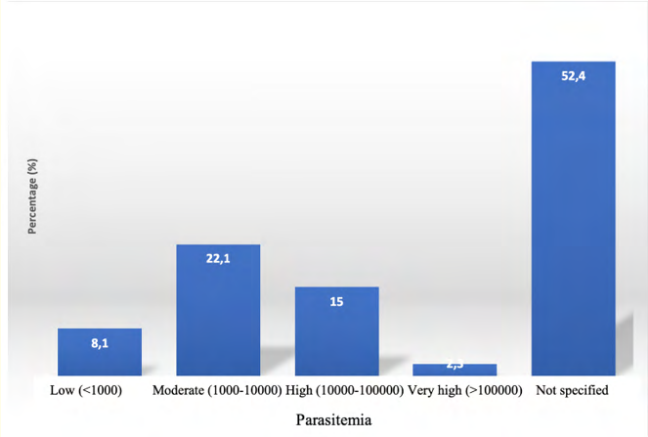

Figure 2: Distribution According to Thick Blood Smear Results (Parasites/µL).

Complete blood count (CBC)

Leukopenia was observed in 19 children (17.9%) and leukocytosis in 55 cases (6.2%). Anemia was present in 297 children (96.7%), thrombocytopenia in 169 children (55%), and thrombocytosis in 30 cases (8.3%). Regarding the ABO/Rh blood group, O+ accounted for 152 cases (49.5%), followed by B+ with 63 cases (20.5%) and A+ with 47 cases (15.3%).

Treatment administered and length of hospital stay

- **Etiological Treatment:** All children received injectable artesunate as first-line therapy, followed by an oral artemisinin-based combination therapy (ACT) as soon as their clinical condition allowed.
- **Symptomatic Treatments:** Antipyretics were the most frequently used, administered in 280 out of 307 cases (91.5%). Anticonvulsants were given to 170 out of 307 children (55.4%). Blood transfusions were administered in 105 out of 307 cases (34.2%), and oral antianemic therapy in 20 out of 307 cases (6.5%). Antiemetics complemented symptomatic management in 64 out of 307 cases (20.8%).

Length of hospital stay

A total of 172 children (56%) were hospitalized for 3 days or less, while 135 children (44%) required hospitalization for more than 3 days.

Outcomes

A total of 298 children (97.1%) recovered. Deaths accounted for 7 cases (2.3%).

Patients discharged against medical advice represented 0.7% (n = 2): one experienced seizures at home and was readmitted, and the other eventually recovered after receiving oral treatment.

Analysis of the association between factors such as age, geographic origin, consultation delay, and clinical outcomes showed that young age (<5 years) was significantly associated with a higher risk of death ($p < 0.05$).

Discussion

Prevalence of severe malaria

The results show a prevalence of 4.06% of severe malaria among children who presented to the pediatric department. This rate is lower than the 24.5% reported by Kadri., *et al*. in 2020 in Niger, and comparable to the 8.02% reported by Okoko., *et al*. in 2016 in Brazzaville [5,6]. This difference may be explained by the specific

characteristics of our study population, particularly the level of exposure to malaria transmission, as well as the challenging socio-environmental context, which may influence both the incidence and severity of the disease.

Sociodemographic characteristics

The predominance of children aged 1–4 years (53.4%) and the fact that 60.2% of cases occurred in children under 5 years are consistent with international literature. Several studies have highlighted the high vulnerability of this age group [5-7]. In young children, this vulnerability is attributed to the immaturity of the immune system—characterized by limited production of specific antibodies and an incomplete cellular response—as well as the absence of acquired immunity, which develops only after repeated exposures to the parasite.

The male predominance (59.9% vs. 40.1%) observed in our study is consistent with findings by Kadri., *et al*. (2020, Niger), Okoko., *et al*. (2016, Brazzaville), and Keita., *et al*. (2024, Koulikoro) [5-7]. This male overrepresentation may be related to behavioral factors, as boys are more frequently involved in outdoor activities (playing, walking), increasing their exposure to mosquito bites.

Clinical characteristics

The clinical presentation in our series aligns with the classical features of severe malaria. Fever, present in 96% of cases, confirms its role as a cardinal sign. The high frequency of seizures (51.8%) highlights the neurological involvement, while respiratory distress manifested by tachypnea was observed in 26.4%. These findings are consistent with those of Keita., *et al*. (2024, Bamako), where fever (32.2%) was the main reason for consultation [7].

These symptoms may be explained by the intense inflammatory response triggered by high parasite density, characteristic of severe malaria in children, as well as by delayed consultation, which favors progression to severe manifestations, especially neurological and respiratory. It is noteworthy that most children in our study were seen relatively early, within 3 days after symptom onset.

Paraclinical characteristics

The complete blood count revealed anemia in 96.7% of cases and thrombocytopenia in 55%. These findings are similar to those of Okoko., *et al*. (2016, Brazzaville), who reported anemia in 61.5% of children, and to Camara., *et al*. (2010, Dakar), who found thrombocytopenia in 37% [5,8].

Severity criteria of malaria

The predominance of recurrent seizures (52.4%) followed by prostration as the main severity criteria differs from other studies where severe anemia was the dominant feature. Our findings are similar to those of Camara., *et al*. (2010, Dakar), who also reported recurrent seizures as the most frequent feature (52.5%), followed by impaired consciousness and prostration [8]. Conversely, studies by Kadri., *et al*. (2020, Niger), Okoko., *et al*. and Keita., *et al*. (2024, Koulikoro) identified severe anemia as the leading severity indicator [5,7].

This particularity may reflect genetic or environmental factors specific to the Senegalese population. It may also be related to the circulating strains of *Plasmodium falciparum* in a given region. Some strains display greater neurotropism, leading to seizures and altered consciousness, whereas others cause more severe hemolysis and profound anemia.

Effectiveness of administered treatments and their impact on mortality and morbidity rates

The exclusive use of injectable artesunate (100%) as the first-line etiological treatment demonstrated excellent adherence to the 2011 WHO guidelines [9]. This result is comparable to that of Traoré in 2021 in Bamako, where artesunate was used in 94% of cases [8]. It contrasts with findings by Kadri., *et al*. in 2020 in Niger, where artesunate was used in only 29% of cases compared to 71% for artemether [10]. The exclusive use of artesunate in our study reflects good drug availability, effective updating of treatment protocols, and strong adherence to WHO recommendations.

Morbidity and mortality related to severe malaria

The recovery rate of 97.1% represents an outstanding outcome, surpassing many studies conducted in Africa. The mortality rate of 2.3% can be attributed to several factors, primarily: the absence of malaria chemoprophylaxis in some localities of the region, delayed consultation between the onset of symptoms and medical care, inadequate management of severity signs, and delayed referral to appropriate healthcare levels. This compares favorably with regional data where pediatric severe malaria mortality typically ranges between 5–20% [3]. The results are similar to those of

Okoko., *et al*. (2016, Brazzaville), Keita., *et al*. (2024, Koulikoro), and Camara., *et al*. (2010, Dakar), who reported recovery rates of 93.5%, 89.9%, and 84.6%, respectively, with corresponding mortality rates of 6.5%, 11.1%, and 5.1% [6-8].

The predominance of deaths among children aged 1–4 years (57.1%), mostly male (57.1%), and the fact that deaths occurred early, exclusively within the first three days of hospitalization, highlight the particular vulnerability of young children to severe malaria [9]. At this age, the immune system has not yet developed partial immunity against *Plasmodium falciparum*, making the infection progress more rapidly and severely.

Conclusion

Malaria remains a major global public health challenge, with a particularly devastating impact in sub-Saharan Africa, disproportionately affecting children, especially those under five years old. In Senegal, despite efforts to control and eliminate malaria, the disease continues to represent a significant public health problem.

Consent for Publication

Consent letters were obtained from the patients or their parents.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

Authors' Contributions

- Basse I, Coly NF, Badji SL, Papetti MZ, Diedhiou B, Sow PS, participated in the design, implementation of the project and the writing of the article.
- Bashi EA, Seck N, Thiam L, Boiro D, Diagne Guéye NR, Ndongo AA, participated in the writing of the article.

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