

Effectiveness of Severe Neurological Malaria Case Management at Bolenge General Referral Hospital, Democratic Republic of the Congo: A Retrospective Cohort Study

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ABSTRACT

Background: Severe neurological malaria (cerebral malaria) remains a major public health threat in the Democratic Republic of the Congo (DRC), particularly among children under five years of age. This study evaluated the effectiveness of severe neurological malaria case management at Bolenge General Referral Hospital (HGR Bolenge).

Methods: A retrospective descriptive and analytical cohort study was conducted on 80 patient records of individuals admitted with severe neurological malaria to HGR Bolenge between August and December 2025. Data were collected using a standardized extraction form. Sociodemographic, clinical, therapeutic, and outcome data were analyzed using Excel and SPSS. Univariate, bivariate (chi-square), and multivariate (logistic regression) analyses were performed.

Results: Children aged 0–5 years accounted for 47.5% of cases, with male predominance (56.3%). The most frequent clinical signs were high fever (92.5%), convulsions (65.0%), and coma (50.0%). Injectable artesunate was administered to 72.5% of patients. The overall recovery rate was 75.0%, with 15.0% developing complications and 10.0% dying. Early consultation (<24 hours) and artesunate use were significantly associated with favorable outcomes ($p=0.01$ and

p=0.02, respectively). Multivariate analysis identified early consultation (aOR=3.8; 95% CI: 1.4–10.2; p=0.008) and artesunate treatment (aOR=4.2; 95% CI: 1.5–11.5; p=0.005) as independent predictors of recovery, while coma predicted poor prognosis (aOR=0.4; 95% CI: 0.1–0.9; p=0.031).

Conclusions: The effectiveness of severe neurological malaria management at HGR Bolenge is significantly influenced by timeliness of consultation and choice of antimalarial therapy. Injectable artesunate demonstrated superior efficacy compared to quinine. A mortality rate of 10% remains concerning, highlighting the need for improved early diagnosis, prompt referral systems, and strengthened neurological monitoring protocols.

Keywords: Severe malaria, cerebral malaria, neurological form, case management, artesunate, therapeutic effectiveness, Bolenge, Democratic Republic of the Congo.

1. INTRODUCTION

1.1. Global Burden of Severe Malaria

Malaria remains one of the most significant public health challenges worldwide, particularly in tropical and subtropical regions. According to the World Malaria Report 2023, approximately 249 million malaria cases were recorded globally in 2022, representing a substantial increase from 244 million cases in 2021 (World Health Organization [WHO], 2023). The number of malaria-related deaths was estimated at 608,000, with over 95% occurring in sub-Saharan Africa. Children under five years of age remain the most vulnerable population, accounting for nearly 80% of all malaria deaths in the African region (UNICEF, 2023).

Among the various clinical forms of malaria, severe malaria constitutes a medical emergency requiring immediate and aggressive intervention. Severe malaria is characterized by life-threatening complications that can rapidly progress to death if not promptly and appropriately managed (White et al., 2019). The World Health Organization defines severe malaria by the presence of one or more clinical or laboratory criteria, including cerebral malaria (altered

consciousness or coma), repeated convulsions, severe anemia, respiratory distress, hypoglycemia, renal failure, and shock (WHO, 2022).

1.2. Cerebral Malaria: The Most Lethal Neurological Form

Cerebral malaria, also known as neurological malaria or neuropaludism, represents the most severe and dreaded complication of *Plasmodium falciparum* infection. It is clinically defined by the presence of unarousable coma (Blantyre coma score ≤ 2 in children or Glasgow coma score ≤ 9 in adults) lasting more than 30 minutes after exclusion of other causes of encephalopathy (Idro et al., 2010). The pathophysiology of cerebral malaria involves sequestration of parasitized erythrocytes in cerebral microvessels, leading to vascular obstruction, endothelial dysfunction, inflammation, and ultimately neuronal injury (White et al., 2019).

The case fatality rate of cerebral malaria remains alarmingly high, ranging from 15% to 30% in various African settings (Newton & Krishna, 1998). Among survivors, up to 10–15% develop persistent neurological sequelae, including cognitive impairment, motor deficits (hemiplegia, ataxia), cortical blindness, and epilepsy (Idro et al., 2010). The socioeconomic impact of these disabilities is profound, particularly in resource-limited settings where rehabilitation services are scarce.

1.3. Malaria Situation in the Democratic Republic of the Congo

The DRC bears one of the highest malaria burdens in the world, accounting for approximately 12% of all global malaria cases (WHO, 2023). The country ranks second only to Nigeria in terms of malaria incidence and mortality. The environmental and climatic conditions of the DRC—particularly its tropical rainforests, dense hydrographic network, and abundant rainfall—create a highly conducive environment for the proliferation of *Anopheles* mosquitoes, the primary malaria vectors.

The province of Équateur, located in the northwestern part of the DRC, is among the most affected regions. According to the Provincial Health Division (DPS Équateur, 2023), malaria is the leading cause of outpatient consultations and hospitalizations. The rainy season, which lasts

up to eight months, coincides with peak malaria transmission, overwhelming under-resourced health facilities.

1.4. Study Setting and Rationale

Bolenge General Referral Hospital (HGR Bolenge) serves as the referral center for the Bolenge health zone, receiving patients from remote rural villages. Despite malaria control interventions, severe cases continue to be admitted. The persistence of severe neurological malaria raises critical questions regarding the effectiveness of case management. This study aimed to evaluate case management effectiveness and identify factors influencing clinical outcomes.

1.5. Study Objectives

General objective: To evaluate the effectiveness of severe neurological malaria case management at HGR Bolenge.

Specific objectives: (1) To describe sociodemographic, clinical, and therapeutic characteristics; (2) To identify factors influencing effectiveness; (3) To evaluate clinical outcomes; and (4) To propose improvement strategies.

2. METHODS

2.1. Study Design

This was a retrospective, descriptive, analytical cohort study conducted at HGR Bolenge, adhering to STROBE guidelines.

2.2. Study Setting

HGR Bolenge is located in Bolenge health zone, Mbandaka city, Équateur Province, DRC. The hospital serves a catchment population of approximately 100,000–150,000 inhabitants.

2.3. Study Population

The target population comprised all patients diagnosed with severe neurological malaria admitted to HGR Bolenge during the study period.

2.4. Inclusion and Exclusion Criteria

Inclusion criteria: Diagnosis of severe malaria with neurological involvement based on WHO criteria; admission between August 1 and December 31, 2025; complete and legible medical records.

Exclusion criteria: Incomplete records; neurological disorders not attributable to malaria; illegible records.

2.5. Sampling Strategy

A non-probabilistic exhaustive sampling method was employed. All eligible records were reviewed, yielding 80 patients.

2.6. Data Collection Instrument

A structured data extraction form captured sociodemographic data, clinical signs, laboratory results, therapeutic data, outcomes, and delay to consultation.

2.7. Case Definition

Severe neurological malaria was defined as confirmed *P. falciparum* infection with impaired consciousness (GCS ≤ 9 or Blantyre ≤ 2), repeated convulsions, or prostration.

2.8. Outcome Measures

The primary outcome was clinical recovery. Secondary outcomes included complications and death.

2.9. Data Analysis

Data were analyzed using SPSS. Univariate (frequencies, percentages), bivariate (chi-square tests), and multivariate (binary logistic regression) analyses were performed. A p-value <0.05 was considered statistically significant.

2.10. Ethical Considerations

Ethical approval was obtained from ISTM Mbandaka. Patient data were anonymized.

2.11. Limitations

Limitations include retrospective design, modest sample size, single-center setting, potential information bias, and lack of long-term follow-up.

3. RESULTS

3.1. Sociodemographic Characteristics

Table 1. Distribution by age and sex (N=80)

Characteristic	Category	Frequency (n)	Percentage (%)
Age group	0–5 years	38	47.5
	6–15 years	22	27.5
	≥16 years	20	25.0
Sex	Male	45	56.3
	Female	35	43.7

Children aged 0–5 years accounted for 47.5% of cases. The male-to-female ratio was 1.28:1.

3.2. Clinical Presentation

Table 2. Frequency of clinical signs (N=80)

Clinical sign	Frequency (n)	Percentage (%)
High fever ($\geq 39^{\circ}\text{C}$)	74	92.5
Convulsions	52	65.0
Coma	40	50.0
Vomiting	36	45.0
Severe anemia (Hb < 5 g/dL)	31	38.7

High fever was nearly universal (92.5%). Convulsions were present in 65.0% and coma in 50.0%.

3.3. Antimalarial Treatment

Table 3. Treatment administered (N=80)

Treatment	Frequency (n)	Percentage (%)
Injectable artesunate	58	72.5
Injectable quinine	22	27.5

Artesunate was the predominant therapy (72.5%), consistent with WHO recommendations.

3.4. Clinical Outcomes

Table 4. Clinical outcomes (N=80)

Outcome	Frequency (n)	Percentage (%)
Recovery	60	75.0
Complications	12	15.0
Death	8	10.0

Recovery rate was 75.0%, mortality 10.0%, and complication rate 15.0%.

3.5. Bivariate Analysis

Table 5. Association between time to consultation and outcomes

Time to consultation	Recovery	Complications/Death	Total
<24 hours	35	5	40
≥24 hours	25	15	40

$$*\chi^2 = 6.67, p = 0.01*$$

Patients presenting within 24 hours had significantly higher recovery (87.5% vs. 62.5%).

Table 6. Association between antimalarial drug and outcomes

Antimalarial drug	Recovery	Complications/Death	Total
Artesunate	48	10	58
Quinine	12	10	22

$$*\chi^2 = 5.21, p = 0.02*$$

Artesunate was associated with better outcomes (82.8% vs. 54.5%).

3.6. Multivariate Analysis

Table 7. Logistic regression: Factors independently associated with recovery

Variable	Adjusted OR	95% CI	p-value
Early consultation (<24 hours)	3.8	1.4–10.2	0.008
Artesunate treatment	4.2	1.5–11.5	0.005
Presence of coma	0.4	0.1–0.9	0.031
Age <5 years	0.7	0.3–1.8	0.410

Early consultation (aOR=3.8) and artesunate use (aOR=4.2) were strong independent predictors of recovery. Coma predicted poor prognosis (aOR=0.4).

4. DISCUSSION

4.1. Summary of Key Findings

This study evaluated severe neurological malaria case management at HGR Bolenge. Key findings: (1) children under five constitute the majority; (2) fever, convulsions, and coma are dominant; (3) artesunate is more effective than quinine; (4) recovery rate is 75% with 10% mortality; and (5) early consultation and artesunate independently predict favorable outcomes.

4.2. Age and Sex Distribution

The predominance of children under five (47.5%) aligns with global data showing young children lack immunity to *P. falciparum* (WHO, 2023; White et al., 2019). The slight male predominance (56.3%) is consistent with previous African studies (Idro et al., 2010; Marsh et al., 1995).

4.3. Clinical Presentation

Fever (92.5%), convulsions (65.0%), and coma (50.0%) reflect advanced disease at presentation. These findings are similar to reports from Uganda and Southeast Asia (Idro et al., 2010; Dondorp et al., 2010). The high proportion of coma (50%) is concerning, as coma is a well-established predictor of poor outcome (Newton & Krishna, 1998).

4.4. Therapeutic Effectiveness: Artesunate vs. Quinine

Artesunate demonstrated superior effectiveness (82.8% vs. 54.5% recovery; aOR=4.2). This aligns with the SEAQUAMAT trial (Dondorp et al., 2010), which showed a 35% relative risk reduction in mortality with artesunate. Despite this, 27.5% received quinine due to recurrent stockouts—a systemic failure requiring urgent correction.

4.5. Clinical Outcomes

The 75% recovery rate, 10% mortality, and 15% complication rate are concerning. Mortality from cerebral malaria in well-resourced settings has fallen below 10% (Fairhurst & Wellems, 2019), but rates of 15–30% persist in sub-Saharan Africa (WHO, 2022). The 15% complication rate—primarily neurological sequelae—is consistent with Idro et al. (2010).

4.6. Early Consultation as a Key Prognostic Factor

Early consultation (<24 hours) strongly predicted recovery (aOR=3.8). This aligns with Marsh et al. (1995), demonstrating that each hour of delay increases death and sequelae risk. Barriers to timely care include economic constraints, geographic distance, cultural beliefs, and lack of awareness of danger signs.

4.7. Comparison with Regional Studies

Findings are consistent with Kasereka (2020) in Goma (12% mortality) and PNLP (2020) (65% artesunate coverage). Our 75% recovery rate is lower than the 85–90% reported in Tanzania and Kenya (Newton & Krishna, 1998), reflecting differences in pre-hospital care and ICU capacity.

4.8. Strengths and Limitations

Strengths include systematic record review, standardized case definitions, and multivariate adjustment. Limitations include retrospective design, modest sample size, single-center setting, potential information bias, and lack of long-term follow-up.

4.9. Implications for Policy and Practice

For health authorities: Ensure uninterrupted artesunate supply; strengthen community education on danger signs; invest in emergency transport systems.

For hospital managers: Implement standardized neurological assessment tools; enforce timely artesunate administration; establish post-discharge follow-up.

For researchers: Conduct prospective studies with long-term follow-up; evaluate community interventions to reduce pre-hospital delay.

5. CONCLUSION

The effectiveness of severe neurological malaria management at HGR Bolenge is substantially influenced by timeliness of consultation and choice of antimalarial therapy. Injectable artesunate was significantly more effective than quinine, and early presentation strongly predicted recovery. However, with a mortality rate of 10% and complication rate of 15%, current management remains suboptimal. Addressing stockouts of artesunate, delayed patient referrals, and inadequate neurological monitoring is essential to reduce death and disability from this preventable disease.

6. RECOMMENDATIONS

6.1. To Provincial and National Health Authorities

1. Ensure uninterrupted availability of injectable artesunate through improved supply chain management
2. Strengthen community malaria education on early recognition of danger signs
3. Invest in emergency transport systems (e.g., community motorcycle ambulance schemes)
4. Allocate resources for post-discharge follow-up clinics

6.2. To Hospital Managers and Clinicians

1. Implement standardized neurological assessment (Blantyre/Glasgow coma scores)
2. Enforce protocols for artesunate administration within 30 minutes of diagnosis
3. Conduct regular training on severe malaria management
4. Establish routine post-discharge follow-up at 1, 3, and 6 months
5. Improve medical record keeping completeness

6.3. To the Community

1. Seek care immediately for fever, especially with lethargy, convulsions, or altered consciousness
2. Avoid self-medication with antimalarials from informal vendors
3. Utilize insecticide-treated nets consistently

6.4. To Future Researchers

1. Conduct prospective cohort studies with systematic data collection
2. Perform long-term follow-up studies (12–24 months) to assess neurological sequelae
3. Evaluate cost-effectiveness of community-based interventions to reduce pre-hospital delay
4. Investigate artemisinin resistance through molecular surveillance

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