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Severe Malaria Comorbidity and Bacterial Infections in Children at the Pediatric Department of Tengandogo University Hospital

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Abstract

Objective: To investigate the clinical, biological, and outcome characteristics of children hospitalized for severe malaria, and to identify factors associated with bacterial co-infection at Tengandogo University Hospital. **Methods:** A cross-sectional, descriptive, and analytical study was conducted from August to October 2022 in the pediatric department. Children aged 1 month to 15 years hospitalized for severe malaria according to WHO criteria were included. Bacterial co-infections were defined by suspected or confirmed clinical, biological (elevated CRP, leukocytosis), radiological, and/or microbiological data. Data were collected from medical records and analyzed using Epi Info 7.22.2.6. Chi-square tests were used to compare proportions, with significance set at $p < 0.05$. **Results:** Of 129 children hospitalized for severe malaria, 45 (34.9%) had bacterial co-infection. The most common infections were bronchopulmonary infections (33.3%), gastroenteritis (17.8%), and urinary tract infections (15.6%). Major clinical signs included coma (51.1%), respiratory distress (48.9%), and severe anemia (68.9%). Mean parasite density was 74,218/µL. Significant risk factors were low socioeconomic status (OR = 2.85), poor general condition (OR = 2.81), coma (OR = 4.12), respiratory distress (OR = 3.77), hypoglycemia < 2.2 mmol/L (OR = 5.74), and in-hospital death (OR = 5.00). Overall case fatality was 20%. **Conclusion:** Bacterial co-infection is frequent in severe pediatric malaria and worsens prognosis. Systematic screening based on simple criteria is essential to optimize management. According to our findings, coma, respiratory distress, and hypoglycemia should be used as simple screening criteria.

Keywords

Severe Malaria, Bacterial Co-Infection, Child, Burkina Faso

1. Introduction

Infectious diseases remain a major cause of morbidity and mortality among children in resource-limited countries. They account for approximately 17 million deaths per year, representing nearly one-third of global mortality [1]. In sub-Saharan Africa, malaria and invasive bacterial infections (IBI) are among the leading causes of pediatric deaths [2].

Malaria continues to be one of the most significant parasitic endemic diseases in Africa, responsible for high mortality, particularly among children. In 2022, WHO estimated 247 million malaria cases worldwide, 95% of which occurred in Africa, with more than 600,000 deaths, predominantly affecting children under five years of age [1]-[3]. In Burkina Faso, malaria is the leading cause of outpatient consultations and hospital mortality [4].

In endemic areas, the clinical presentations of acute febrile illnesses are often polymorphic. Distinguishing between severe malaria and invasive bacterial infection (IBI) is difficult, especially since both conditions may coexist. This association worsens prognosis, increasing the risk of shock, severe anemia, hypoglycemia, or coma [5]-[7].

Data on severe malaria-IBI co-infection remain limited in Burkina Faso, particularly in referral centers. Improving patient management requires better knowledge of the frequency of this comorbidity, associated factors, and local clinical profiles.

The present study aims to determine the frequency of bacterial co-infections among children hospitalized for severe malaria at Tengandogo University Hospital, describe their clinical and biological characteristics, and identify factors associated with this comorbidity.

2. Materials and Methods

This was a cross-sectional, descriptive, and analytical study conducted from August 1 to October 31, 2022, in the pediatric department of Tengandogo University Hospital (CHU-T), Ouagadougou, Burkina Faso. CHU-T is a national referral facility that admits medical emergencies.

The study population included children aged 1 month to 15 years hospitalized for severe malaria. The definition of bacterial co-infection was based on suspected or confirmed clinical syndromes (bronchopneumopathy, urinary tract infection, meningitis, septicemia) and/or biological abnormalities (leukocytosis, CRP > 20 mg/L); radiological abnormalities; or microbiological documentation (blood culture, urinalysis, cerebrospinal fluid). Sampling was exhaustive.

Data were collected from anonymized forms, medical records, and hospitaliza-

tion registers. Variables studied included sociodemographic characteristics (age, sex, residence, socioeconomic level), clinical features (general condition, nutritional status, temperature, danger signs), biological parameters (thick smear, blood film, complete blood count, CRP, blood glucose, blood cultures, urinalysis, lumbar puncture, chest X-ray), therapeutic management (treatments administered at admission), and outcomes (length of hospitalization, favorable or unfavorable outcome). Given the known association between malnutrition and infection, nutritional status was analyzed as a potential risk factor for bacterial co-infection.

Statistical analysis was performed using Epi Info and Excel software. Data were processed using descriptive (frequencies, means, standard deviations) and analytical approaches (Chi-square test, odds ratio with 95% confidence interval). The significance threshold was set at $p < 0.05$.

The study complied with ethical principles, with institutional authorization and parental informed consent. Operational definitions were applied: anemia was classified into three levels according to hemoglobin concentration: severe (<5 g/dL), moderate (5 - 10 g/dL), absent (>10 g/dL). Socioeconomic level was assessed using an asset score (low: 0 - 3, medium: 4 - 7, high: >7). Nutritional status was defined according to weight-for-height Z-score: good (> −2), fair (−3 to −2), poor (<−3). Major hyperthermia was defined as body temperature ≥ 40˚C.

3. Results

3.1. Epidemiological Data

3.1.1. Frequency

Among the 129 children hospitalized for severe malaria, 45 presented with bacterial co-infection, representing a prevalence of 34.88%.

3.1.2. Sociodemographic Characteristics

The majority of co-infected children were under five years of age (75.6%), male (51.1%), and from rural areas (71.1%). Socioeconomic status was low in 82.2% of cases (Table 1).

Table 1. Sociodemographic characteristics of co-infected children (n = 45).

Variable	Category	Number	Percentage (%)
Sex	Male	23	51.11
	Female	22	48.89
Age (months)	<6	1	2.22
	6 - 59	34	75.56
	≥60	10	22.22
Geographic origin	Rural area	32	71.11
	Urban area	13	28.89
Socioeconomic level	Low	37	82.22
	Medium	6	13.33
	High	2	4.45

3.1.3. Therapeutic Pathway

Most children (80%) initially consulted another healthcare facility. The mean duration of illness before admission was 4 days, with 55.55% admitted after more than 3 days of symptoms. Previous hospitalization was noted in 26.67% of children, and 95.56% were referred from another facility.

3.2. Clinical and Biological Data

Among the 45 children with severe malaria-bacterial co-infection, the main clinical and biological characteristics observed are summarized in Table 2.

Table 2. Clinical and biological signs in co-infected children (n = 45).

Parameter	Category/Value	Number	Percentage (%)
General condition	Poor	31	68.89
	Fair	13	28.89
	Good	1	2.22
Nutritional status	Good	32	71.11
	Fair	7	15.56
	Poor	6	13.33
Temperature	≥40˚C	4	8.89
Danger signs	Intractable vomiting	21	46.67
	Others	9	20.00
Severe anemia	Hb < 5 g/dL	31	68.89
Severe hypoglycemia	Blood glucose < 2.2 mmol/L	12	26.67
CRP	>20 mg/L	42	93.33
Thick smear	Positive	21	46.67

The mean parasite density was 74,218/µL (range: 117 - 680,000/µL).

3.3. Profile of Associated Bacterial Infections

Bronchopneumopathies were the most frequent form (33.33%), followed by gastroenteritis (17.78%) and urinary tract infections (15.56%) (Table 3). Microbiological examinations identified infectious agents in 10 cases. Two blood cultures revealed *Escherichia coli* and *Klebsiella pneumoniae*. Eight chest X-rays showed bronchopathies and pneumonias.

Table 3. Profile of associated bacterial infections.

Type of infection	Number	Percentage (%)
Bronchopneumopathies	15	33.33
Gastroenteritis	8	17.78
Urinary tract infections	7	15.56
Acute meningitis	5	11.11
Septicemia	5	11.11

3.4. Treatment at Admission

Almost all children (97.78%) received a combination of injectable artesunate and antibiotics. The most commonly used regimen was artesunate plus ceftriaxone (73.33%).

3.5. Outcomes

The mean duration of hospitalization was 4.93 days. The outcome was favorable in 77.78% of children. Case fatality was 20%.

3.6. Factors Associated with Bacterial Co-Infection

Several epidemiological, clinical, biological, and outcome-related factors were significantly associated with severe malaria-bacterial co-infection in hospitalized children, as shown in Table 4. The signs most significantly associated with co-infection were hypoglycemia (OR = 5.74; p = 0.002), coma (OR = 4.12; p = 0.0004), and respiratory distress (OR = 3.77; p = 0.001). Nutritional status was not significantly associated with co-infection (OR = 2.00, p = 0.25).

Table 4. Parameters statistically associated with severe malaria-bacterial co-infection.

Category	Factor studied	Cases (Yes/No)	p-value	OR (95% CI)
Epidemiological	Low socioeconomic status	37/52	0.017	2.85 (1.18 - 6.87)
Clinical	Poor general condition	31/37	0.007	2.81 (1.31 - 6.04)
Severity signs	Coma	23/17	0.0004	4.12 (1.87 - 9.08)
	Respiratory distress	22/17	0.001	3.77 (1.71 - 8.31)
Biological	Hypoglycemia (<2.2 mmol/L)	12/5	0.002	5.74 (1.87 - 17.60)
Outcome	In-hospital death	9/4	0.011	5.00 (1.44 - 17.30)

4. Discussion

4.1. Study Limitations

This study presents the inherent limitations of cross-sectional surveys, which provide a snapshot without allowing causal relationships to be established. It was conducted during the rainy season, a period of high malaria transmission in Burkina Faso, which limits the generalization of results to the dry season. The high cost of certain complementary tests (procalcitonin, blood cultures) restricted their use, reducing the precision of microbiological diagnosis. Furthermore, the broad definition of co-infections may have overestimated their frequency. The temporary closure of pediatric emergency services also impacted the number of patients included. In addition, the widespread empirical use of antibiotics at admission may have reduced the diagnostic yield of microbiological tests such as blood cultures.

4.2. Frequency of Severe Malaria-Bacterial Co-Infection

The observed frequency (34.88%) is close to that reported by Sagbo *et al.* in Benin

(38.8%) [6] and higher than that observed by Kouéta *et al.* at CHUP-CDG in Ouagadougou (13.6%) [5]. These differences may be explained by inclusion criteria: some studies were limited to bacteremia confirmed by culture, whereas the present study included both suspected and confirmed bacterial infections. The rainy season, conducive to malaria and respiratory infections, may also have contributed to this high frequency.

4.3. Sociodemographic Characteristics

A slight male predominance (51.11%) was observed, consistent with the findings of Kouéta *et al.* [5]. Male morbidity is common in pediatrics, with some authors suggesting that the second X chromosome in girls provides greater immune protection [8] [9]. The age group of 1 to 59 months accounted for 77.78% of cases, confirming the vulnerability of young children. This susceptibility may be explained by the loss of maternal immunity after 6 months and the introduction of poorly diversified foods, favoring malnutrition and infections [10]. The majority of children came from rural areas (71.11%), reflecting the reality of CHU-T, a referral facility receiving patients from peripheral communities. This profile is consistent with the findings of Sagbo *et al.* [6], who also observed a high proportion of patients from rural settings. Children from families with low socioeconomic status accounted for 82.22% of cases. This factor is recognized as a determinant in the occurrence of severe childhood diseases, particularly malaria and malnutrition [10]. Although nutritional status was assessed, it was not significantly associated with co-infection in this cohort, suggesting that other factors such as disease severity and delayed care may have played a more prominent role.

4.4. Therapeutic Pathway

The majority of children (95.56%) were referred from another healthcare facility, which is expected in a tertiary center such as CHU-T. This high referral rate reflects the severity of cases and the proper functioning of the triage system. However, more than half of the children were admitted after over three days of symptoms, and this delay in reaching tertiary care may have contributed to increased clinical severity and poorer outcomes.

4.5. Clinical and Biological Data

The most frequent severity signs were severe anemia (77.78%), coma (51.11%), and respiratory distress (48.89%). These results are similar to those reported by Sagbo *et al.* [6] and Kouéta *et al.* [5], who also identified these signs as predictive of co-infection. The mean parasite density was 74,218/µL. Severe anemia was present in 68.89% of children, with a mean hemoglobin level of 4.89 g/dL. Severe hypoglycemia (<2.2 mmol/L) was observed in 26.67% of cases, and CRP > 20 mg/L in 93.33% of cases. These biological abnormalities are consistent with WHO severity criteria [3] and regional studies [5] [6].

4.6. Associated Bacterial Infections

The most frequent infections were bronchopneumopathies (33.33%), gastroenteritis (17.78%), urinary tract infections (15.56%), acute meningitis (11.11%), and septicemia (11.11%). These findings are consistent with those of Sagbo *et al.* [6], who observed a similar diversity of infectious sites. Microbiological examinations identified *Escherichia coli* and *Klebsiella pneumoniae* in two cases. This diversity highlights the need for comprehensive and tailored management.

4.7. Factors Associated with Co-Infection

Low socioeconomic status was significantly associated with co-infection, confirming its role as a risk factor [10]. Significant deterioration of general condition, coma, and respiratory distress were associated with co-infection, consistent with the findings of Kouéta *et al.* [5] and Sagbo *et al.* [6]. These signs reflect the clinical severity of the association between severe malaria and bacterial infections. A significant association was also found with hypoglycemia, which appears to be a relevant biological marker. Mortality was significantly higher among co-infected children (20%), consistent with the findings of Kouéta *et al.* [5], who reported a case fatality rate of 16% in co-infected cases. This excess mortality underscores the importance of strengthening diagnostic and therapeutic capacities for bacterial infections associated with severe malaria. The identification of coma, respiratory distress, and hypoglycemia as key predictors suggests that these simple clinical and biological signs could guide early screening for co-infection in resource-limited settings.

5. Conclusion

Severe malaria-bacterial co-infection is frequent and significantly worsens the prognosis of children hospitalized at Tengandogo University Hospital. Clinicians should be particularly vigilant in children presenting with coma, respiratory distress, or hypoglycemia. These simple criteria should be used to guide systematic screening for bacterial co-infection. Improving access to microbiological tests, strengthening screening, training healthcare personnel, and optimizing therapeutic protocols could reduce mortality related to these co-infections.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] World Health Organization (2022) World Malaria Report 2022. World Health Or-

ganization.

[2] UNICEF (2022) Levels and Trends in Child Mortality: Report 2022. UNICEF.

[3] World Health Organization (2022) Malaria Fact Sheet. World Health Organization.

[4] Ministry of Health of Burkina Faso (2022) Statistical Yearbook 2021. Directorate General of Sectoral Studies and Statistics (DGESS).

[5] Kouéta, F., Kaboré, A., Nagalo, K., Kaboret, S., Dao, L., Ouédraogo-Yugbaré, S.O. and Yé, D. (2016) Severe Malaria with Invasive Bacterial Infections in Children in a Paediatric Service in Sub-Saharan Africa. *International Journal of Contemporary Pediatrics*, **3**, 8-11. https://doi.org/10.18203/2349-3291.ijcp20160136

[6] Sagbo, G.G., Alao, M.J., d'Almeida, M., Lalya, F. and Ayivi, B. (2011) Bacterial Infection during Severe Malaria in Infants under Six Months at CNHU of Cotonou, Benin. *Clinical Mother and Child Health*, **8**, 4.

[7] Church, J. and Maitland, K. (2014) Invasive Bacterial Co-Infection in African Children with Plasmodium Falciparum Malaria: A Systematic Review. *BMC Medicine*, **12**, Article No. 31. https://doi.org/10.1186/1741-7015-12-31

[8] Maltha, J., Guiraud, I., Kaboré, B., Lompo, P., Ley, B., Bottieau, E., *et al.* (2014) Frequency of Severe Malaria and Invasive Bacterial Infections among Children Admitted to a Rural Hospital in Burkina Faso. *PLOS ONE*, **9**, e89103. https://doi.org/10.1371/journal.pone.0089103

[9] Feng, Z., Liao, M. and Zhang, L. (2024) Sex Differences in Disease: Sex Chromosome and Immunity. *Journal of Translational Medicine*, **22**, Article No. 1150. https://doi.org/10.1186/s12967-024-05990-2

[10] Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., de Onis, M., Ezzati, M., *et al.* (2008) Maternal and Child Undernutrition: Global and Regional Exposures and Health Consequences. *The Lancet*, **371**, 243-260. https://doi.org/10.1016/s0140-6736(07)61690-0