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CASE REPORT

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Neonatal and congenital malaria (NCM): a case series in the Tigray region, northern Ethiopia

Yemane Leake Gebremichael[1], Hindeya Hailu Hagos[1*], Birhanu Kassie Reta[2], Tiegst Bahta Woldu[3], Kinfe Redae Berhe[4], Fantay Gebremariam Gebrearegay[5] and Gebremeskel Kiros Tsegay[6]

Abstract

Background Congenital malaria (CM) is the direct infection of a neonate with malaria parasites from their mother before or during birth. Neonatal malaria (NM) is acquired through mosquito bites after birth during the neonatal period. Both congenital and neonatal malaria (NCM) are potentially life-threatening conditions. There is limited recognition and experience with NCM in the Tigray region of Ethiopia. This case series aims to raise clinicians' awareness of NCM screening, treatment, and prevention, particularly in endemic areas.

Methods This case series was conducted in the neonatal intensive care unit of Miani General Hospital, Tigray region, northern Ethiopia, from January to May 2024. Neonates with persistent and/or high-grade fever and those with a delayed response to first-line antibiotics were selectively screened for malaria using thin and thick blood smears. Neonates with positive results for malaria species were included; others were excluded.

Case presentations Six cases are described: four congenital and two neonatal malaria cases. The neonates' ages at admission ranged from 1 to 16 days. All six neonates were presented by their caregivers with the primary complaint of fever. Blood smears revealed ring stages of *Plasmodium falciparum* in four neonates, *Plasmodium* vivax in one neonate, and a mixed infection of *P. falciparum* and *P. vivax* in another. All six neonates received antimalarial medication and first-line antibiotics. While five neonates recovered; one died.

Conclusion Neonatal and congenital malaria should be considered in any newborn presenting with clinical features of neonatal sepsis from a malaria-endemic area. Therefore, routine malaria prevention strategies and screening tests should be implemented for neonates in malaria-endemic areas.

Keywords Congenital malaria, Neonatal malaria, Neonate, Malaria, Tigray

*Correspondence:
Hindeya Hailu Hagos
hailuhndeya698@gmail.com
Full list of author information is available at the end of the article

Background

The World Health Organization (WHO) Global Technical Strategy calls for at least a 90% reduction in malaria case incidence and mortality rates by 2030, relative to the 2015 baseline [1]. Meeting this goal requires early identification, prevention, and treatment of malaria in all age groups, including neonates. Ethiopia is a high-burden malaria country, with 75% of its total area malarious and approximately 52% of its population living in malaria risk areas [2]. *Plasmodium falciparum* and *Plasmodium vivax* are the two dominant malaria-causing parasite species in Ethiopia, with relative frequencies of approximately 60% and 40%, respectively [2].

Congenital malaria results from the trans-placental transmission of malaria parasites from mother to baby in utero or feto-maternal transmission during labour and delivery [3]. Diagnosis is similar to that in other age groups, involving the detection of asexual forms of malaria parasites in thin and thick blood smears. Rapid diagnostic tests can also be used, particularly in resource-limited and endemic areas. The reported incidence of congenital malaria in endemic regions is variable [4–7]. For example, Kokori and associates in a systematic review reported that the prevalence of congenital malaria in Nigeria varies significantly across different studies, ranging from as low as 5.1% to as high as 96.3% [8].

Although the definitions of neonatal and congenital malaria are controversial, most studies define congenital malaria as, malaria that occurs and manifests during the early neonatal period, i.e., the first seven days of life. However, it can manifest beyond the first week of life for various reasons, including persistent maternal IgG in the newborn's blood, slow clearance of parasites from fetal circulation, and the presence of fetal haemoglobin [3, 9]. In addition, the incubation period for *P. falciparum* is more than 9 days, and in malaria-endemic areas, neonates could still be at risk of mosquito bites and thus acquire malaria. Neonatal malaria is considered to occur and manifest during the late neonatal period, i.e., days 8–28 of life [3, 4, 9]. These controversies can be resolved by PCR testing for malaria in mothers and neonates, which can establish a temporal relationship [4]. However, PCR tests for malaria are very limited in low-resource countries, such as Ethiopia.

While neonatal and congenital malaria (NCM) is widely recognized in most parts of the world, including Africa, it is under-recognized, and little experience is available regarding the burden of NCM in the Tigray region specifically (to the best of our knowledge, this is the first report from Tigray) and in Ethiopia generally. Diagnosing NCM can be challenging in malaria-endemic areas where there are overlapping clinical signs and symptoms of malaria and sepsis. Thus, this case series aims to raise clinicians'awareness of NCM screening, treatment, and prevention in endemic areas.

Methods

Study design, area, and period

This is a case series study conducted at Miani General Hospital, located in the Tigray region of northern Ethiopia, a few kilometres away from the Eritrean border. The war in the Tigray region, which began in November 2020 and ended with a lasting peace agreement between the Tigray region and the FDRE in Pretoria, South Africa, in November 2022, resulted in a near-collapse of the region's health system and infrastructure [10–12]. The hospital was significantly damaged, looted, and vandalized by the Ethiopian National Defense Force, Eritrean forces, and Amhara special forces and militia during their occupation. The Tigray region was under siege and blockade for two years, cut off from the rest of the world, and the hospital infrastructure was significantly damaged [10, 12]. There were no medications, vaccines, or other medical supplies, and routine services had completely stopped. After the cessation of hostilities agreement, the hospital resumed emergency services and then gradually resumed routine services. It serves an estimated one million people, including internally displaced people (from western Tigray), and serves as a referral center for health centers, health posts, and primary hospitals within its catchment area. It provides a wide range of services, including outpatient and inpatient medical, surgical, maternal, and child health services. Additionally, it provides laboratory and radiology services. It is staffed with specialists, general practitioners, nurses, midwives, and other support staff. A neonatal intensive care unit (NICU) is one of the hospital's units, serving approximately 50 neonatal admissions per month. The study was conducted from January to May 2024. Malaria is endemic and is among the leading causes of morbidity and mortality in its catchment area population.

Inclusion and exclusion criteria

Neonates admitted to the NICU for sepsis were the study's source population. Those with high-grade and/or persistent fever, as well as those with delayed or no response to first-line antibiotics, were selectively screened for malaria using thin and thick blood smears. Among these, those who tested positive for *Plasmodium* species were included; others were excluded.

Summary of the case presentations

This study included six cases: four of congenital malaria and two of neonatal malaria. Maternal ages ranged from 23 to 30 years, and parity ranged from 1 to 5. All mothers received regular antenatal care at nearby health centres.

Four of the six mothers had a history of malaria during their current pregnancy, and one had a history of malaria in the immediate postpartum period. The male-to-female ratio was 2:1. Neonatal admission ages ranged from 1 to 16 days; all neonates were born at term. Birth weights of four neonates ranged from 3.0 to 3.5 kg; those of the other two were unknown. Admission weights ranged from 2.0 to 2.8 kg. All patients presented with fever. One neonate also exhibited altered mental status and abnormal body movements. On examination, all six neonates were febrile (38–40 °C). Other findings varied and are detailed in subsequent case discussions. None of the mothers received malaria preventive measures, such as intermittent preventive treatment, due to the collapse of the regional health system resulting from the war, siege, and blockade in Tigray.

Routine laboratory investigations were performed with the following results: two patients exhibited hypoglycaemia (low blood sugar), five had normal complete blood counts, one had severe anaemia and mild thrombocytopenia. Thick and thin blood smears revealed ring stages of *P. falciparum* in four cases, P. *vivax* in one, and mixed *P. falciparum* and *P. vivax* in one neonate. All patients received antimalarial and first-line antibiotics according to the Ethiopian national malaria protocol and WHO recommendations, with varying lengths of hospitalization. Two patients were treated for hypoglycaemia with a bolus of 10% dextrose in water, followed by a standard glucose infusion rate of 6 mg/kg/min until normalization. One patient received weight based two transfusions of cross-matched whole blood. Of the six neonates, five were successfully treated and discharged (hospital stays varied), and one died during treatment. Case details are provided below; Table 1 summarizes key parameters.

Patient 1

A 32-h-old female neonate was born to a 30-year-old para-V mother via vaginal delivery at 39 weeks and 2 days of gestational age at a nearby health centre. Labour lasted 5 h, and the membrane ruptured intrapartum. The birth weight was 3000 g, and the Apgar score was unknown, but she cried immediately after birth. She received regular antenatal care (ANC) four times at the nearby health centre, was screened for TORCH infections, and the results were non-reactive. She had no history of malaria attacks. The mother brought her neonate to the clinic with a complaint of high-grade fever and excessive crying that started at one day old. On admission, the neonate was irritable, with a pulse rate of 140 bpm, febrile (38 °C), and weighed 3000 g. Other vital signs were within normal limits. Thick and thin blood smears detected *P. falciparum*. Her blood glucose and hemoglobin levels were 69 mg/dl and 14 g/dl, respectively. A diagnosis of congenital malaria and early-onset neonatal sepsis (EONS) was made. She was treated with intravenous artesunate at a dose of 3 mg/kg/dose for five days, in accordance to the Ethiopian and WHO guidelines. In addition to antimalarial, a seven-day course of first-line antibiotics (ampicillin and gentamicin) was administered. She recovered and was discharged after a 7-day hospital stay. She appeared well at a follow-up clinic visit.

Patient 2

A 3-day-old male neonate was born to a 23-year-old para I mother via spontaneous vaginal delivery at 40 weeks and 3 days of gestation at a nearby health centre. The total duration of labour was 8 h. The membrane ruptured intrapartum. The birth weight was 3500 g, and the Apgar score was unknown, but he cried immediately after birth. The mother had regular antenatal care (ANC) follow-up at a nearby health facility. She had a history of a malaria attack in the seventh month of the present pregnancy and was treated according to the guidelines. The neonate was brought with complaints of high-grade fever and intense crying since birth. Additionally, he had refused breastfeeding and decreased urine output since the second day of life. On examination, the patient appeared acutely ill, with a pulse rate of 178 bpm, fever (40 °C), and an admission weight of 3000 g. Other vital signs were within the normal range. Other system examinations were unremarkable. A thick and thin blood film was performed, revealing *P. falciparum* with + + parasite density. His blood glucose level was 46 mg/dL, indicating hypoglycaemia, and his haemoglobin level was 14.9 g/dL. A diagnosis of congenital malaria, hypoglycaemia, and neonatal dehydration secondary to poor intake and early-onset neonatal sepsis (EONS) was made. He received a bolus of 10% dextrose in water and then a continuous glucose infusion at a rate of 6 mg/kg/min until his blood glucose normalized. He also received a single resuscitation bolus of 10 ml/kg normal saline. Intravenous artesunate at a 3 mg/kg/dose was administered for five days according to the Ethiopian national malaria protocol. Additionally, he received first-line antibiotics, ampicillin and cefotaxime, for sepsis. He was discharged after a 7-days hospital stay. At the follow-up clinic, the patient was in stable health condition with optimal growth patterns.

Patient 3

A 24-h-old male neonate, born to a 26-year-old Para III mother via spontaneous vaginal delivery at 39 weeks and 1 day gestation, was delivered at a nearby health centre. His birth weight was 3000 g, and although his Apgar score is unknown, he cried immediately after birth. Labour lasted 6 h, and the membrane ruptured intrapartum. The mother had regular and uneventful antenatal care (ANC)

Table 1 Summary of admission characteristics and treatment outcomes, cases of congenital and neonatal malaria, Tigray region, northern Ethiopia

Characteristics	Congenital malaria				Neonatal malaria	
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Maternal						
Age (year)	30	23	26	26	30	30
Parity	5	1	3	3	NA	4
Malaria treatment history	No	Yes	No	Yes	Yes	Yes
Neonate						
Age (d/H)	32 H	3d	1d	3d	16d	10d
Sex	Female	Male	Male	Male	Male	Female
Birth wt(kg)	3	3.5	3	Unknown	3.2	Unknown
Admission wt (kg)	2.8	3	3	3	2.7	2
Symptoms						
Fever	Yes	Yes	Yes	Yes	Yes	Yes
Duration of fever (d)	01	03	1	3	3	03
Fast breathing	No	No	No	No	No	Yes
Poor breastfeeding	No	Yes	No	No	No	Yes
Signs						
Temperature (Celsius)	38	40	39	39	39	39
Jaundice	No	No	No	No	No	Yes
Pallor	No	No	No	No	No	Yes
RR(breath/min)	44	46	42	45	50	72
SPO2(atm oxygen)	93%	92%	95%	94%	94%	80%
Hepatomegaly	No	No	No	No	No	No
Splenomegaly	No	No	No	No	No	Yes
Laboratory						
Haemoglobin(g/dl)	14	14.9	16.2	15.6	16.4	6.7
Malaria						
Blood smear	P.f	P.f	P.f	P.v	P.f	P.f & P.v
Treatment						
Oxygen	No	No	No	No	No	Yes
Antimalarial	Yes	Yes	Yes	Yes	Yes	Yes
Antibiotics	Yes	Yes	Yes	Yes	Yes	Yes
Blood transfusion	No	No	No	No	No	Yes
Outcome at discharge	Recovered	Recovered	Recovered	Recovered	Recovered	died

D day, *H* Hour, *Pf* Plasmodium falciparum, *Pv* Plasmodium vivax, *NA* Not available, *wt* weight

follow-up at her nearby health centre and no history of malaria attacks. The neonate was brought to the hospital with a complaint of high-grade fever since birth. On examination, he appeared acutely ill, with a pulse rate of 150 bpm and a fever of 39 °C. His admission weight was 3000 g. Other systems examinations were unremarkable. Thick and thin blood smears revealed *P. falciparum* with + + parasite density. His haemoglobin was 16.2 g/dL. A diagnosis of congenital malaria and early-onset neonatal sepsis (EONS) was made. He received intravenous artesunate at a dose of 3 mg/kg/dose for five days, according to the national protocol. First-line antibiotics were administered for 7 days. He improved and was discharged after 7 days of hospitalization. At follow-up, the patient appeared stable, with optimal growth patterns.

Patient 4

A 3-day-old male neonate was born to a 26-year-old Para III mother via spontaneous vaginal delivery at 39 weeks and 4 days of gestation at a nearby health centre. His birth weight and Apgar score are unknown, but he cried immediately after birth. The mother had regular, uneventful antenatal care (ANC) follow-up. She experienced malaria attacks soon after birth in her immediate

postpartum period and was treated at the referring health centre. The neonate was referred to our hospital for further workup and care due to a high-grade fever since birth. A malaria rapid diagnostic test (RDT) performed at the referring health centre showed P. *vivax*. He received one dose of chloroquine there. On admission to our centre, the acutely ill patient had a pulse rate of 152 bpm and a temperature of 39 °C. His weight was 3000 g. Other system examinations were unremarkable. Thick and thin blood smears revealed *P. vivax* with + + parasite density, consistent with the RDT result from the referring health centre. A diagnosis of congenital malaria and early-onset neonatal sepsis (EONS) was made. He was treated with intravenous artesunate at a dose of 3 mg/kg/dose for five days, according to the Ethiopian national malaria protocol. First-line antibiotics were also administered for 7 days. At follow-up, the patient was in good health with an optimal growth pattern.

Patient 5

A 16-day-old male neonate was born to a 30-year-old mother at 38 weeks and 5 days of gestation via spontaneous vaginal delivery, with a birth weight of 3200 g. The Apgar scores at 1 and 5 min were 8 and 9, respectively. The mother had regular antenatal care (ANC) follow-up at her nearby health facility, which was uneventful. She had a history of malaria attacks prior to the present pregnancy. The neonate was brought in with a complaint of abdominal distention, vomiting of breast milk, and decreased urine output for 3 days. On examination, the patient appeared acutely ill, with a pulse rate of 180 bpm, a temperature of 39 °C, and a weight of 2700 g. Other vital signs were within the normal range. His HEENT examination revealed pink conjunctiva and non-icteric sclera. The abdomen was distended and soft, without organomegaly on palpation. The rest of the systemic examination was unremarkable. The patient was investigated with both thin and thick blood smears, which revealed P. *falciparum* with a + parasite density. A diagnosis of neonatal malaria and early-onset neonatal sepsis (EONS) was made. He received intravenous artesunate at a dose of 3 mg/kg per dose for 7 days, in accordance with the national malaria treatment protocol. A course of first-line antibiotics was also administered.

However, abdominal distension persisted, prompting the continuation of antibiotics for a total of two weeks. Further evaluations, including an abdominal ultrasound and monitoring of vital signs, were normal. After a two-week hospital stay, the patient was discharged with marked clinical improvement. At the follow-up clinic visit, he remained stable and demonstrated optimal growth patterns.

Patient 6

A 10-day-old female neonate, born vaginally at 38 weeks and 3 days gestation to a 30-year-old para IV mother at a nearby health centre. Birth weight and Apgar score were unknown, but the neonate cried immediately after birth. The mother had three uneventful antenatal care (ANC) visits at a nearby health facility. She had a history of malaria treatment early in the pregnancy. The neonate presented with a 3-day history of high-grade fever, abnormal body movements (2–3 episodes/day), vomiting of breast milk, decreased mentation, and anuria, associated with significant weight loss. No Rh or ABO incompatibility was detected. On admission, the neonate was lethargic, with a pulse of 180 bpm, respiratory rate of 68 bpm (tachypneic), and was febrile (40 °C). Oxygen saturation was 80% on room air. Admission weight was 2000 g. His HEENT exam revealed pale conjunctiva and icteric sclera. Chest exam showed subcostal and intercostal retractions with good bilateral air entry. Abdominal exam revealed splenomegaly. Musculoskeletal exam showed a bony appearance, slow skin turgor, pallor, and fast capillary refill. Jaundice extended to the chest. Neurologic exam revealed lethargy and depressed primitive reflexes. A thick and thin blood smear was performed and showed mixed *P.falciparum* and *P. vivax* infections, each with + parasite density. Her blood glucose level was 35 g/dL, indicating hypoglycaemia. Furthermore, a complete blood count revealed a white blood cell count of 10,000, a platelet count of 123,000 (mild thrombocytopenia), and a haemoglobin level of 6.7 g/dL (severe anaemia). She was admitted with a diagnosis of neonatal malaria, neonatal seizures secondary to cerebral malaria, meningitis, and hypoglycaemia. In addition, pre-renal azotaemia secondary to sepsis and malaria was considered. A diagnosis of severe sepsis involving the central nervous system, hematologic and respiratory systems was also included in the diagnosis. She was managed with intranasal oxygen (1 L per minute), a 4 mL/kg bolus of 10% dextrose in water followed by a continuous glucose infusion rate of 6 mg/kg/minute until her blood glucose normalized. She was resuscitated with 20 mL/kg normal saline twice, but she did not pass urine. Furthermore, she was transfused with 20 ml/kg fresh whole blood two times and was started on a 3 mg/kg/dose of intravenous artesunate according to the national malaria protocol. In addition, she started on first-line antibiotics, i.e., ampicillin and cefotaxime at a meningeal dose. Besides, she was loaded and reloaded with phenobarbital. However, she did not respond and was again loaded with phenytoin and then continued with maintenance doses of both drugs. Indeed, a weight based diazepam was given as needed. The families were advised referral to a level III NICU centre for further management and investigations, such as renal function

tests and electrolyte determination. However, the families refused the referral and the physician in charge advised them on the prognosis. She was on treatment and routine intensive care unit (ICU) care at our centre until she died at 48 h of admission.

Discussion

Ethiopia remains one of the countries with a high malaria burden, with 75% of the total area being malarious and approximately 52% of the population living in a malaria risk area [2]. *Plasmodium falciparum* and *P. vivax* are the two dominant parasite species causing malaria in Ethiopia, with relative frequencies of approximately 60% and 40%, respectively [2]. The epidemiology of congenital and neonatal malaria is elusive in Ethiopia, except for a few case reports and series, particularly in the Tigray region.

Variable degrees of fever, starting from the first day of life and beyond, is the most common presentation of NCM [4–6]. A systematic review conducted by Kokori and colleagues in Nigeria reported fever as a universally observed manifestation of congenital malaria across the reviewed studies [8]. Likewise, all our patients were brought by their caregivers primarily with the complaint of fever. Similarly, Olupot-Olupot and his colleagues, in their case series, reported that 3 of the 4 NCM cases presented with fever [4]. Malaria should be considered as a cause of fever in the neonatal period, and appropriate malaria tests should be performed, particularly in malaria-endemic areas.

However, a significant number of NCM patients in endemic areas can present with atypical manifestations, including poor feeding, jaundice, excessive crying, diarrhoea, vomiting, convulsions, anaemia, thrombocytopenia, hypoglycaemia, respiratory distress, hepatomegaly, splenomegaly, bloody stools, hypothermia, apnea, and cyanosis; some may be asymptomatic [6, 13–16]. Tesso and associates in their case series from southern Ethiopia reported three neonates with NCM who presented without fever [17]. Their primary presentations were pallor, inconsolable crying, abdominal distension, anemia, and splenomegaly [17]. In this study, two patients had hypoglycaemia; one patient also had respiratory distress, pallor, jaundice, anemia, thrombocytopenia, and splenomegaly. In addition, another patient experienced abdominal distension. At their initial visits, neonates with malaria usually present with features of sepsis. The concomitant presence of sepsis and malaria in neonates is characterized by fever, vomiting, abdominal distension, decreased breastfeeding, irritability, changes in mentation, and abnormal laboratory parameters such as low blood glucose levels and anaemia [5]. Thus, it might be challenging and can be potentially misdiagnosed and mistreated.

In endemic areas, a high suspicion of malaria, especially when fever persists and there is a delayed or absent response to standard antibiotic treatment, should be considered an important clue. In such cases, an immediate and appropriate malaria workup should be pursued. All six patients presented with features of neonatal sepsis, and first-line antibiotics were initiated upon admission. However, despite antibiotic treatment, fever persisted in most patients in this report, and an early suspicion of malaria was raised in some. Indeed, the results revealed various *Plasmodium* species. Nevertheless, a significant number of patients with negative malaria tests responded well to the addition of antimalarial medications. This highlights that neonatal and congenital malaria should also be considered clinically in endemic areas.

Malaria endemicity has been suggested to play a role in the prevalence of NCM. Vertical transmission is low in hyperendemic areas and high in low-endemic areas due to immune development [3]. The placenta can be infected in one-third of mothers living in endemic areas, even if they are asymptomatic [13, 18]. Placental malaria significantly increases the risk of perinatal morbidity and mortality, including low birth weight, intrauterine growth restriction, preterm labour, and intrauterine fetal death [3]. The placental transfer of antibodies prevents the clinical manifestation of malaria in neonates despite the presence of malaria parasites in their blood. In addition, the presence of fetal haemoglobin, which has a different morphology than adult haemoglobin, prevents malaria infection in neonates [18, 19]. Both the maternal transfer of immunoglobulin and fetal haemoglobin wane at similar times, with a half-life ranging from 3 to 6 months, at which time malaria attacks and severe cases appear [19, 20]. Furthermore, maternal breast milk is also unfavourable for the multiplication of malaria parasites because of the presence of low iron and amino acid (p-aminobenzoic acid) content, which the parasite uses during replication in the human body.

The diagnostic modalities for neonatal and congenital malaria (NCM) include thin and thick blood smears, rapid diagnostic tests (RDTs), and molecular tests such as PCR. Although there is a low density of circulating parasites in neonates, a thin and thick blood film is regarded as the standard diagnostic modality [1]. All six of the patients were diagnosed using blood smear. One patient underwent a malaria RDT at the referring health centre, which revealed *P. vivax*. The blood film obtained at our centre for this patient also revealed P. vivax, consistent with the RDT result. When available, PCR tests are excellent for cases with low parasite density, such as in neonates [13]. One study indicated that real-time PCR yields higher positivity rates than blood smears from the peripheral blood of neonates [13]. According

to the authors, all placental malaria cases confirmed by real-time PCR were also confirmed microscopically [13]. However, this diagnostic method is difficult to use in low-income countries like ours for obvious reasons.

The treatment of NCM is usually off-label, similar to that of older children. Indeed, parenteral treatments are better for neonates and young infants for various reasons [4]. Moreover, infants can deteriorate rapidly; therefore, there should be a low threshold for parenteral treatment [4]. In this study, intravenous artesunate at a dose of 3 mg/kg/dose was used in all patients. This is in line with Ethiopian and WHO malaria guidelines. The duration of treatment mainly depends on the patient's condition, including the presence of complications, and can last five to seven days. Although artemisinin-based combination therapy (ACT) is the recommended treatment for uncomplicated malaria in infants, neonates have been largely excluded from ACT clinical trials for safety reasons [3]. Furthermore, the WHO currently allows infants weighing less than 5 kg to be treated similarly to older infants [1].

The WHO acknowledges that most antimalarial drugs lack infant formulations, which can lead to under dosing or overdosing [4]. This was observed in one of the patients, who took a higher dose of chloroquine before referral to the hospital. The other standard treatment for malaria in older children is primaquine. However, primaquine is contraindicated during pregnancy, in breastfeeding mothers, and in infants under six months of age due to insufficient data in these populations [1]. Nonetheless, studies have reported no significant side effects in those older than 28 days [4]. Similar to other drugs, due to the physiological immaturity and rapid changes in neonates, the pharmacokinetic and pharmacodynamics profiles of antimalarial drugs are likely different from those in older children [21]. All our patients received first-line antibiotics for varying durations due to indistinguishable signs and symptoms and the possibility of co-occurring bacterial infections.

The study has an important limitation: mothers and neonates were not screened concomitantly for malaria, which could hinder a more complete understanding of the condition.

Conclusion and recommendation

In conclusion, neonatal and congenital malaria should be considered in any newborn presenting with clinical features of neonatal sepsis from a malaria-endemic area. Emphasizing prevention, routine blood smears for malaria screening and early treatment of malaria in neonates with features of sepsis in endemic areas may help reduce morbidity and mortality. Moreover, this case series highlights the need for clinicians in malaria-endemic areas to routinely perform malaria tests on neonates. Given that neonates are a vulnerable population group, we recommend that future researchers conduct appropriately designed, large-scale studies focused on neonatal and congenital malaria (NCM) in malaria-endemic settings. In addition, implementing malaria prevention strategies during pregnancy, is recommended in accordance with WHO recommendations.

Abbreviations

ANC	Antenatal care
APGAR	Appearance, pulse, grimace, activity, respiration
CM	Congenital malaria
EONS	Early-onset neonatal sepsis
FDRE	Federal democratic republic of Ethiopia
NCM	Neonatal and congenital malaria
NICU	Neonatal intensive care unit
PCR	Polymerase chain reaction
TORCH	Toxoplasmosis, others, rubella, cytomegalovirus, herpes
WHO	World Health Organization

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Author contributions

Yemane Leake Gebremichael: Conceptualization, Visualization, Supervision, Writing- Original draft preparation. Hindeya Hailu Hagos: Data curation, Writing- Original draft preparation. Birhanu Kassie Reta: Visualization, Investigation, Writing review and editing. Tiegst Bahta Woldu; Writing review and editing, Kinfe Redae Berhe; Writing review and editing, Fantay G/mariam G/Aregay; Writing review and editing, Gebremskel Kiros Tsegay; Writing review and editing.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Ethical approval for the publication of this case report was obtained from the Aksum University College of Health Science ethics committee with approval number IRB 098/2025.

Consent for publication

Written informed consent was obtained from the patients' parents for publication of this case series. A copy of the written consent is available for review by the editor-in-chief of this journal upon request.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Pediatrics and Child Health, Aksum University College of Health Science, Postal code 7080, Aksum, Tigray, Ethiopia. [2]Department of Pathology, Aksum University College of Health Science, Aksum, Ethiopia. [3]Department of Pharmacy, Pharmacognosy Unit, Aksum University College of Health Science, Aksum, Ethiopia. [4]Tigray Regional Health Bureau, Miani General Hospital, Sheraro, Ethiopia. [5]International Medical Corps (IMCs), Shire, Ethiopia. [6]Médecins Sans Frontières (MSF), Korem, Ethiopia.

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