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CASE SERIES

A Case Series: A Mother and Daughter with a Critically Low Hemoglobin Level Resulting from Severe Anemia Secondary to Malaria

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Background: Malaria can lead to anemia, a condition marked by a reduction in red blood cells or lower than typical levels of hemoglobin. This condition mainly affects women and children and, in severe cases, can hinder the cognitive and motor development of children. It also poses significant risks for pregnant women and their unborn children.

Case presentation: An 18-month-old girl and her mother, referred from conflict-affected West Wollega, Ethiopia due to severe malaria, were admitted to Assosa General Hospital, Ethiopia, with critical health indicators. The daughter (case 1) had a hemoglobin level of 0.8 g/dL, a red blood cell count of 0.44 × 10^6u/L, an oxygen saturation of 90%, a body temperature of 36.6 °C, a heartbeat of 132 beats per minute, and a respiratory rate of 48 breaths per minute. She displayed signs of pale conjunctivitis and severe palmar paleness, and weighed 7 kg. The mother(case 2), aged 35, also had a history of severe malaria and presented with a critically low hemoglobin level of 2.5g/dL and a red blood cell count of 0.75 × 10^6u/L, with an oxygen saturation of 89%. Blood transfusion and malaria treatment were administered, and by the end of their hospital stay, both cases' symptoms had resolved, and they returned to normal baseline vital signs, including their hemoglobin levels.

Conclusions: Severely low hemoglobin levels, worsened by severe malaria, present a significant danger in cases of anemia. As far as I am aware, this might be the lowest hemoglobin level recorded. Promoting awareness, economic empowerment initiatives, alongside routine provision of iron supplements and Prompt malaria diagnosis and treatment to create a comprehensive approach that addresses the multifaceted challenges posed by anemia, ultimately leading to improved health outcomes for vulnerable populations.

Keywords: hemoglobin, anemia, malaria, case series

Background

Acute and recurrent malaria are the primary infections that cause anemia in sub-Saharan Africa.[1] Malaria can result in anemia.[2] A condition marked by a reduction in red blood cells or lower than typical levels of hemoglobin. This condition predominantly impacts women and children. In severe instances, Anemia can result in hindered cognitive and motor development in children. Furthermore, it can pose significant risks for pregnant women and their unborn children. Including our country Ethiopia and others low- and lower-middle-income setup, the Preeminent recognized causes of anemia are iron deficiency and malaria means Iron deficiency and malaria are widely recognized as the primary causes of anemia. Children under the age of 5 are among the population groups most susceptible to anemia, particularly infants and children under 2 years old, adolescent girls experiencing menstruation, as well as women who are pregnant or in the postpartum period.[3]

Anemia is a frequent complication in cases of malarial infection, stemming from various pathophysiological mechanisms. In regions where malaria is prevalent, additional health issues such as parasitic infestations, deficiencies in iron, folate, and Vitamin B12, as well as other nutrient deficiencies, can exacerbate anemia. Furthermore, the use of anti-malarial drugs can worsen anemia through both immune and non-immune mechanisms, making it an important factor to consider.[4] It is suggested that *Plasmodium falciparum* infection is partially associated with an elevated risk of severe anemia.[5]

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Anemia remains a pervasive and substantial global health issue that still needs sufficient attention, especially in Low- and Middle-Income Countries (LMICs) where the advancement has been sluggish and inconsistent.[6]

The West Wollega region of Oromia, Ethiopia, is in the midst of a severe crisis. The area's healthcare infrastructure has suffered significant damage, resulting in fatalities, forced migration, and a range of adverse effects. In recent years, violence and infrastructure destruction have significantly hindered the local population's ability to access essential services such as education, healthcare, and water and sanitation. In Western Oromia, 426 health facilities are reportedly non-functional due to looting and damage.[7,8]

According to a report by the International Committee of the Red Cross (ICRC), the ongoing conflict in Ethiopia's Oromia region has had a severe effect on essential infrastructure, including healthcare facilities and water systems. In Beghi district, which has a population of 100,000, nearly all of the 42 health posts have been either pillaged or damaged.[9] This has resulted in a situation where individuals with life-threatening medical conditions are unable to access urgent care due to the non-operational health facilities. These include long-term losses in social capital, social networks, and infrastructure, as well as damage to institutions that results in social, political, and economic harm.[10]

The region's healthcare infrastructure has been severely compromised due to a variety of factors, making the situation in West Wollega particularly alarming, the consequences of these conflicts on public health system and facilities resulting restrictions on delivering essential healthcare services are a significant source of worry. This situation requires immediate attention and action from all stakeholders to restore peace and rebuild the healthcare infrastructure. It is also vital to provide urgent humanitarian assistance to the affected population.[11]

It is crucial to conduct a case series on low hemoglobin levels in malaria and anemia areas for several reasons. Firstly, it can provide valuable insights into the impact of these conditions on hemoglobin levels, which can aid in understanding the severity and progression of the diseases. Additionally, such reports can contribute to the creation of efficient diagnostic and treatment approaches for individuals residing in these regions. Furthermore, critical case series can help raise awareness about the public health implications of low hemoglobin levels in malaria and anemia areas, potentially leading to improved interventions and healthcare policies.

Case Presentation

Case 1

A previously healthy 18-month-old girl was transferred to Assosa General Hospital, Ethiopia from Beghi Primary Hospital in the Western Oromia region of Ethiopia, where the healthcare system is significantly impacted by conflict and war. Armed conflicts are causing destruction to the public health infrastructure and disrupting healthcare services in Oromia. These conflicts are displacing individuals from their homes, compelling them to reside in makeshift shelters, which could lead to significant health crises.[10] The effects of these conflicts on public health infrastructure and the resulting limitations on providing essential public healthcare services would be significant.[11] This has alarmingly led to a high number of deaths among children due to malaria and anemia.

This little girl had been experiencing symptoms such as fatigue, vomiting, cough, loss of appetite, and dizziness for a week. She had difficulty breastfeeding. Her vital signs indicated an oxygen saturation of 90%, body temperature of 36.6 °C, blood pressure of 100/70 millimeter of mercury(mmHg), heart rate of 132 beat per minutes(bpm), and respiratory rate of 47 breaths per minute. She exhibited signs of Pale Conjunctivitis and severe palmar paleness, weighed 7 kg, and had a mid-upper arm circumferences(MUAC) of 11.5. She was noticeably weak and had difficulty latching onto the breast during feeding. Her mucous membranes and conjunctiva were noticeably pale. She was having difficulty breathing in room air and showed signs of breathlessness.

Immediately upon she arrived at emergency room she was admitted directly to the pediatrics ward with her mother, The laboratory examination for a complete blood count was requested, which confirmed clinical signs of severe anemia with a hemoglobin level of 0.8 g/dL, as determined by the CBC machine, significantly below the normal range. The test was done before any medical intervention. After gathering additional information about the past from the family, that she has experienced anemia.

The initial laboratory findings from complete blood count (CBC) are outlined in Table 1. Upon arrival, girls level of hemoglobin (Hgb) was alarmingly low at 0.8 g/dL, along with below 70.0 fL mean corpuscular volume (MCV).

Table 1 The Case Report of Mother and Daughter with a Critical Low of Hemoglobin Due to Severe Anemia Secondary to Malaria, Initial CBC Result for Case and Case 2

Exam Name	Case 1	Case 2
	Initial Result	Initial Result
RBC	0.44 × 10^6u/L.	0.75 × 10^6u/L.
HGB	0.8 g/dL	2.5g/dL
HCT	3.1%	8.3%
MCV	70.5fl	110fl
MCH	18.2pg	33.3pg
MCHC	25.8 g/dL	30.1 g/dL
PLT	63 × 10^3u/L.	232 × 10^3u/L.
RDW-SD	45.2fl	97.8fl
RDW-cv	29.6fl	28.8fl
RDW	9.8fl	12.0fl
MPV	9.4fl	10.9
P-LCR	22.1%	30.7%
PCT	0.06%	0.25%
WBC	8.4810^3u/L	41.59*10^3u/L
Neut	33.3%	46.5%
lymph	58.6%	42.4%
mono	7.2%	9.4%
E.O	0.7%	1.4%
BASO	0.2%	0.3%
IG	2.5%	8.2%

Note: Key for CBC count.
Abbreviations: RBC, Red Blood Cell Count; Hgb Hemoglobin, Hct Hematocrit; MCV, Mean Corpuscular Volume; MCH, Mean Corpuscular Hemoglobin; MCHC, Mean Corpuscular Hemoglobin Concentration; PLT, Platelets; RDW SD, Red Cell Distribution Width - Standard Deviation; Red Cell Distribution Width - Coefficient of Variation; MPV, Mean Platelet Volume, Platelet-Large Cell Ratio, PCT Plateletcrit; WBC, White Blood Cell Count; NEUT, neutrophil count; LYMPH, Lymphocyte count; MONO, monocytes; EO, Eosinophils; BASO, basophils, IG Immature Granulocytes.

Additionally, her hematocrit was significantly low at 3.1%. The red blood cell distribution width (RDW) was 45.2%, and the red blood cell (RBC) count was 0.44 × 10^6u/L.

The other laboratory test result

- Blood group- O+ve
- RBS 186
- Blood Film-positive for plasmodium falciparum

The correct course of antibiotic treatment was initiated, and a blood transfusion was requested. However, the transfusion was postponed due to a shortage of blood at the Assosa Hospital's blood bank. While waiting, an IV line was established for the girl, and she was started on antibiotics. She was also placed on a concentrator for duration of three days. The child's condition was critical and she was on the verge of death when the blood for transfusion finally became available. The transfusion was successfully performed without any issues, leading to a substantial rise in her hemoglobin level from 0.5 g/dl to 9 g/dl, and her hematocrit increased from 3.1% to 36%. Despite the blood transfusion, the child still exhibited symptoms of respiratory distress, a fast heart rate (known as tachycardia), quick breathing (referred to as tachypnea), and heightened irritability. To alleviate these symptoms, oxygen therapy was administered.

Case 2

A woman of 35 years, accompanied by her daughters, was referred from Beghi Primary Hospital in Ethiopia with a diagnosis of severe anemia and a history of severe malaria. Her husband brought her to the hospital. Upon her arrival at the emergency room, the physician reviewed her referral sheet and additional diagnoses such as blood sugar test, stool examination, and blood type. The physician then ordered a complete blood count (CBC) as indicated on Table 1, and a blood film for malaria testing. The test results confirmed that she was positive for malaria and was suffering from severe anemia, with a hematocrit level of 8.3% and an RBC count of 0.44 × 10^6u/L. She was immediately admitted for a blood transfusion and other necessary treatments, along with her daughter.

The other laboratory test result for case 2

- Blood group- O+ve
- RBS 124g/dl
- Blood film-positive for *plasmodium falciparum*

Treatment with antimalarial and antibiotics was started to address co-infections and prevent potential secondary bacterial infections. However, even though a blood transfusion was requested, it was postponed for 3 days after admission due to a lack of blood in the blood bank. After the blood transfusion was performed, the patient's hemoglobin level rose significantly from 3g/dl to 10 g/dl after receiving just one unit of blood. Importantly, the patient did not need an additional unit of blood transfusion.

While the mother was in the pediatric ward, nurses from the medical ward continued to monitor her. During their hospital stay of 5 days, both the mother and daughter each received a unit of whole blood transfusion, and the daughter was also given an artesunate injection, ceftriaxone, and a paracetamol suppository. On the 5th day, both patients were discharged with plans for follow-up care. At the time of discharge, the post-test results showed hemoglobin and hematocrit levels of 10 g/dL and 30%, and 12 g/dL and 36%, respectively. Blood smears were taken prior to discharge to confirm that the malaria infection had been cleared. Both patients were able to eat and showed relief from their symptoms, with their vital signs returning to normal. Specifically, their oxygen saturation was at 99% and 98%, body temperatures were 36 °C and 36.2°C, blood pressures were 110/70 mmHg and 120/60mmHg, heart rates were 137 and 65 beats per minute, and respiratory rates were 37 and 16 breaths per minute, respectively for the first and second case.

Discussion

Both the mother and daughter displayed typical indications of severe anemia and malaria. In Ethiopia, the diagnosis of severe malaria is made based on a combination of clinical and laboratory standards. The Ethiopian Ministry of Health sets the national guidelines that typically guide the diagnosis and treatment of severe malaria. Microscopy is the standard method used for diagnosing malaria at health centers and hospitals.[12]

To evaluate the severity of the disease and identify any complications, additional laboratory tests may be performed. These can include a complete blood count (CBC) to check for anemia and thrombocytopenia, blood chemistry tests to assess organ function, and blood glucose monitoring. The daughter was notably weak and had difficulty suckling. The CBC revealed significant iron deficiency, microcytosis, an elevated RDW, and low hemoglobin levels. Malaria tests also returned a positive result. To my knowledge, this is the lowest hemoglobin level recorded in a patient who is awake, alert,

and breathing normal air. Previous studies have reported initial laboratory data showing a critically low hemoglobin (Hgb) level of 1.4 g/dL upon arrival.[13] However, this case was distinctive as the patient's vital signs were unstable and she experienced severe weakness throughout her body. Another study involving patients in the intensive care unit (ICU) showed that lower hemoglobin levels were associated with a higher likelihood of worsening respiratory function scores the following day.[14]

The case of the mother and daughter shows that they have severe anemia according to the WHO diagnostic guidelines. Anemia is considered mild when the hemoglobin concentration is less than 11 g/L or hematocrit is less than 33%, while severe anemia is defined as hemoglobin below 50 g/L and hematocrit less than 15%. When mild and severe anemia occurs alongside Plasmodium falciparum infection, it is referred to as uncomplicated and severe malarial anemia. Despite a study conducted in our area suggesting that the association of malaria and anemia is difficult to explain because some individuals experience parasitemia without malarial disease, malaria by Falciparum was the most common cause in 46 cases (46%) of severe anemia admitted to the hospital.[15]

Once more, in this research, both mothers and daughter were found to have tested positive for *Plasmodium falciparum*, which is the primary cause of anemia. Studies conducted in Nigeria also demonstrated that Anemia was found in 47.3% of children, and malaria was recognized as a contributing factor to the occurrence of anemia in these children.[16]

Obtaining blood for transfusion proved to be a crucial and difficult task, particularly because the blood bank in Assosa had exhausted its reserves. This scarcity impacted not just our patient, but also numerous others from areas affected by conflict who depend on Assosa General Hospital for healthcare. The need for blood transfusions in these regions is substantial due to persistent violence, displacement, and restricted access to healthcare services.

Assosa general hospital encountered numerous patients with severe anemia requiring transfusions from the same conflict-affected areas. The scarcity of blood in the blood bank underscores the urgent need to address the challenges of blood supply in regions affected by conflict. Efforts to improve access to blood transfusions, such as organizing blood donation drives, deploying mobile blood collection units, and strengthening community engagement and education, are essential to meet the healthcare needs of these vulnerable populations. Collaborative initiatives involving healthcare providers, local authorities, and community leaders are crucial in addressing these systemic challenges and ensuring access to life-saving interventions for patients in conflict-affected areas.

Boosting Health Infrastructure: Make it a priority to improve and rebuild health facilities, including hospitals, clinics, and medical supply chains, to ensure the provision of vital health services. Assistance for At-Risk Groups: Execute specialized initiatives to aid at-risk groups, including women, children, and the elderly, who might encounter increased health threats in times of conflict.

Collaborate with humanitarian organizations Consider iron supplementation for individuals at high risk of iron deficiency, coordinate efforts and maximize the impact of healthcare interventions in conflict-affected areas Promotion of Peace and Reconciliation, as a stable and peaceful environment is essential for the functioning of an effective healthcare system.

By prioritizing these recommendations, it is possible to begin rebuilding and strengthening healthcare systems in conflict-affected areas, ultimately improving the health and well-being of the population.

Conclusions

In conclusion, it is imperative to recognize that critically low hemoglobin levels, exacerbated by severe malaria, pose a significant threat in cases of anemia. Critically low hemoglobin is a known complication of anemia, and it is worsened by severe malaria. As far as I am aware, this might be the lowest hemoglobin level recorded. Enhancing the educational attainment of families, promoting awareness, and implementing economic empowerment initiatives, alongside routine provision of iron supplements, are crucial components in the fight against anemia and in improving the health of women and children. Quick diagnosis and treatment of malaria are crucial in reducing the likelihood of severe anemia. By diagnosing and treating malaria promptly, the risk of severe anemia can be reduced, improving the overall health and well-being of individuals affected by the disease. These strategies can work synergistically to create a comprehensive approach that addresses the multifaceted challenges posed by anemia, ultimately leading to improved health outcomes for vulnerable populations.

Abbreviations

WHO, World Health Organization; BGRS, Benishangul Gumuz regional state; MOH, Ministry of Health, EPHI, Ethiopian Public Health Institute; RHB, Regional Health Bureau; ICU, Intensive Care Unit; mmHg, millimeter of mercury, bpm, breath per minutes, beat per minutes(bpm), CBC, complete blood count, ESR erythrocyte sedimentation rate, RBC, red blood cell; hemoglobin; MUAC, mid-upper arm circumference, dl deciliter, ICRC, International Committee of the Red Cross.

Ethical Considerations

The study was carried out in accordance with the principles of the Declaration of Helsinki. A formal letter of permission has been obtained from Assosa general hospital management bodies; the study did adversely not affect the rights and welfare of the human.

Consent for Publication

The father of the daughter and the mother's provided consent for the publication and use of data in research. The report does not contain any information that could lead to the patient's identification.

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Disclosure

The author reports no competing interests in this work.

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