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Navigating Hemolysis in Expectant Mothers with Sickle Cell Anemia: Best Practices and Challenges

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ABSTRACT

Sickle cell anemia presents a multifaceted challenge in pregnancy due to increased hemolysis and associated complications for both mother and fetus. This review article aims to explore the nuanced landscape of managing hemolysis in expectant mothers with sickle cell anemia, focusing on best practices and challenges. The paper investigates the pathophysiological underpinnings of hemolysis in sickle cell anemia, emphasizing its exacerbation during pregnancy. It delves into preconception counseling and care, highlighting the significance of early intervention and comprehensive management strategies. Throughout gestation, continuous monitoring and tailored interventions are vital, necessitating close collaboration among multidisciplinary teams comprising hematologists, obstetricians, perinatologists, and genetic counselors. Best practices encompass various approaches, including hydroxyurea therapy and transfusion when warranted, although their safety during pregnancy remains a subject of ongoing research. The review navigates through challenges stemming from limited empirical data and ethical considerations, illuminating the complexities faced in decision-making regarding treatments that benefit both mother and fetus. In conclusion, this review underscores the critical need for a multidimensional approach in managing hemolysis in expectant mothers with sickle cell anemia. It accentuates the importance of individualized care, continuous research endeavors, and the development of evidence-based guidelines to address the intricate clinical landscape and improve outcomes for this vulnerable patient population.

Keywords: Sickle Cell Anemia, Hemolysis, Pregnancy, Maternal Health, Fetal Health, Anemia

INTRODUCTION

Sickle cell anemia, an inherited hemoglobinopathy characterized by abnormal hemoglobin production, poses considerable challenges during pregnancy due to heightened risks of hemolysis and associated complications. Hemolysis, the premature destruction of red blood cells, exacerbates the chronic anemia and vaso-occlusive crises inherent in this condition, imposing substantial risks to both the expectant mother and the developing fetus [1-1]. Pregnancy itself induces physiological changes that further complicate the management of sickle cell anemia. These changes, including increased blood volume, hypercoagulability, and alterations in immune function, intricately interact with the underlying pathophysiology of sickle cell disease, intensifying the risks of complications such as pre-eclampsia, preterm labor, fetal growth restriction, and maternal morbidity [12-21]. This paper aims to comprehensively explore the best practices and challenges in navigating hemolysis specifically in expectant mothers afflicted with sickle cell anemia. By examining the intricate interplay between the pathophysiology of sickle cell disease and the unique challenges posed by pregnancy, this article seeks to shed light on the optimal strategies for managing hemolysis during gestation. Understanding the pathophysiological mechanisms driving hemolysis in sickle cell anemia and how they are influenced by the physiological changes of pregnancy is crucial. Moreover, this review will explore the best practices employed in preconception counseling and care, monitoring strategies during pregnancy, available

therapeutic interventions, and the multidisciplinary approach necessary for comprehensive management [22-31]. Despite advancements in understanding and managing sickle cell disease, several challenges persist. The scarcity of empirical evidence and comprehensive studies focusing on pregnant women with sickle cell anemia limits the establishment of clear guidelines. Ethical considerations surrounding the use of certain therapeutic modalities during pregnancy further complicate decision-making for healthcare providers [32-41]. Therefore, this paper aims to consolidate existing knowledge, identify gaps in current practices, and emphasize the need for further research to enhance the care provided to expectant mothers grappling with sickle cell anemia and hemolysis during pregnancy. By examining both the best practices and the challenges inherent in managing this complex medical scenario, this review seeks to provide valuable insights for healthcare professionals involved in the care of pregnant women with sickle cell anemia.

Pathophysiology of Hemolysis in Sickle Cell Anemia

Sickle cell anemia is a hereditary blood disorder primarily characterized by a mutation in the beta-globin gene, leading to the production of abnormal hemoglobin known as hemoglobin S (HbS). This mutation results in the formation of sickle-shaped red blood cells, which are less flexible and more prone to hemolysis, or premature breakdown [42-45]. The fundamental pathophysiology of hemolysis in sickle cell anemia revolves around the unique properties of these sickle-shaped red blood cells. Under certain conditions, typically triggered by low oxygen levels, these abnormal red blood cells become rigid, leading to their adherence to blood vessel walls and obstructing blood flow. This phenomenon, known as vaso-occlusion, contributes significantly to tissue ischemia, pain crises, and end-organ damage in individuals with sickle cell disease [46-48]. Moreover, sickle red blood cells have a significantly shorter lifespan than normal red blood cells, leading to chronic hemolysis. As a result, there is a continuous breakdown of these cells, leading to anemia, characterized by a decreased number of red blood cells and reduced oxygen-carrying capacity of the blood. The abnormal sickle-shaped cells are less deformable and tend to stick together, causing blockages in small blood vessels. This process leads to tissue damage, pain crises, and the release of inflammatory mediators [49]. The adhesion of sickle cells to the endothelium contributes to vaso-occlusion, causing ischemia and tissue damage. This recurrent process triggers acute pain episodes and exacerbates hemolysis. Sickled red blood cells are more susceptible to oxidative damage due to the increased production of reactive oxygen species. This oxidative stress contributes to further red blood cell damage and hemolysis. Chronic hemolysis leads to the release of free hemoglobin and heme, which scavenges nitric oxide, impairing endothelial function and leading to vasoconstriction and pro-inflammatory states. During pregnancy, the physiological changes further complicate the pathophysiology of hemolysis in sickle cell anemia. The increased blood volume, hormonal fluctuations, and altered immune response can exacerbate hemolysis, leading to complications such as anemia, thrombosis, and vaso-occlusive crises [50-58]. Understanding the intricate mechanisms underlying hemolysis in sickle cell anemia is crucial for devising targeted interventions aimed at mitigating the complications associated with increased red blood cell destruction. Strategies focusing on reducing hemolysis, improving red blood cell lifespan, and minimizing vaso-occlusive events are essential for optimizing maternal and fetal outcomes in pregnant women with sickle cell anemia.

Best Practices in Managing Hemolysis in Pregnant Women with Sickle Cell Anemia:

Effective management of hemolysis in pregnant women with sickle cell anemia requires a multifaceted approach involving preconception care, vigilant monitoring during gestation, and tailored interventions aimed at minimizing complications [59-68]. Early and comprehensive preconception counseling is critical for women with sickle cell anemia planning pregnancy. Genetic counseling should be offered to assess the risks of sickle cell disease inheritance and to discuss options for prenatal diagnosis [69-78]. Managing comorbidities such as infections, iron overload, and other complications before conception is vital to ensure the best possible maternal health during pregnancy. Folic acid supplementation and prophylactic antibiotics should be considered to prevent infections and complications [79-88]. Hydroxyurea has shown promise in reducing hemolysis, decreasing the frequency of vaso-occlusive crises, and improving overall outcomes in non-pregnant individuals with sickle cell disease. While evidence regarding its safety during pregnancy is evolving, it may be considered in certain cases under close monitoring [89-94]. In cases of severe anemia or complications such as acute chest syndrome or stroke, red blood cell transfusions may be necessary. Transfusions also help reduce the sickle cell burden and improve oxygen delivery to tissues [95]. A collaborative team involving hematologists, obstetricians, perinatologists, genetic counselors, and other specialists is essential. This multidisciplinary approach ensures comprehensive care, allows for prompt intervention, and tailors treatment plans to

individual patient needs [96]. Adequate pain management strategies should be employed to alleviate vaso-occlusive crises, a common complication of sickle cell disease. Supportive care, including hydration, adequate rest, and psychological support, plays a crucial role in managing the overall well-being of pregnant women with sickle cell anemia [97]. Patient education about the condition, warning signs of complications, and the importance of adherence to medications and appointments is pivotal. Empowering patients with self-management strategies can aid in better coping with the challenges posed by sickle cell anemia during pregnancy. Continued monitoring and care post-delivery are essential to address potential complications and ensure the well-being of both the mother and the newborn. Despite these best practices, challenges persist, including the limited availability of robust data specific to pregnant women with sickle cell anemia, ethical considerations surrounding medication use during pregnancy, and the need for further research to establish clear guidelines for optimal management strategies.

Challenges in Managing Hemolysis

Managing hemolysis in pregnant women with sickle cell anemia presents several challenges that healthcare providers encounter when striving to optimize maternal and fetal outcomes [98]. The scarcity of comprehensive studies and empirical data specifically focusing on pregnant women with sickle cell anemia poses a significant challenge. The lack of large-scale clinical trials or longitudinal studies hampers the establishment of evidence-based guidelines for managing hemolysis in this specific population. Ethical considerations regarding the use of certain therapeutic interventions during pregnancy remain a challenge. Balancing the potential risks and benefits of treatments for the mother against the potential risks to the developing fetus presents ethical dilemmas for healthcare providers. This includes concerns about the safety of medications, transfusion therapy, or experimental treatments during pregnancy [99]. Balancing maternal health needs while ensuring optimal fetal well-being is complex. Interventions aimed at managing hemolysis in the mother might not always align with what is best for the developing fetus. The potential conflict in treatment strategies between maternal health and fetal health can pose significant challenges in decision-making. Pregnant women with sickle cell anemia are at increased risk of complications such as pre-eclampsia, preterm birth, intrauterine growth restriction, and maternal morbidity. Managing these complications alongside hemolysis requires a comprehensive and nuanced approach [100]. There may be variability in approaches to managing hemolysis among healthcare providers due to the absence of standardized guidelines. This variability can lead to inconsistencies in care and treatment decisions, affecting patient outcomes. Socioeconomic factors, including limited access to healthcare services, disparities in healthcare delivery, and inadequate resources in certain regions or communities, can exacerbate the challenges faced by pregnant women with sickle cell anemia. Hemolysis and associated complications during pregnancy can have long-term implications for both the mother and the child, impacting their health beyond the gestational period. Longitudinal studies assessing the long-term outcomes for both the mother and the offspring are limited [98]. Addressing these challenges requires concerted efforts in research, ethical considerations, and the development of clear and evidence-based guidelines. Collaborative efforts among healthcare professionals, policymakers, researchers, and patient advocacy groups are essential to overcome these challenges and improve the care and outcomes of pregnant women with sickle cell anemia dealing with hemolysis. Efforts to enhance access to care, promote research initiatives, and develop consensus-based guidelines are crucial in mitigating these challenges and improving clinical outcomes for this vulnerable population.

RECOMMENDATIONS

Encourage and support further research specifically focused on pregnant women with sickle cell anemia to fill the gaps in knowledge regarding optimal management strategies. Foster large-scale prospective studies or clinical trials to assess the safety and efficacy of interventions aimed at reducing hemolysis during pregnancy. Develop comprehensive and evidence-based clinical guidelines specific to managing hemolysis in pregnant women with sickle cell anemia. Establish standardized protocols for monitoring, intervention thresholds, and treatment strategies to ensure consistency in care across healthcare settings. Emphasize the importance of multidisciplinary collaboration among healthcare professionals involved in the care of pregnant women with sickle cell anemia. Facilitate regular meetings or case conferences involving hematologists, obstetricians, perinatologists, genetic counselors, and other specialists to provide integrated care and formulate individualized management plans. Develop educational resources tailored for expectant mothers with sickle cell anemia, focusing on disease management, recognizing warning signs, and the importance of compliance with medications and follow-up appointments. Encourage patient involvement in decision-making processes by

fostering open communication and shared decision-making between healthcare providers and patients. Offer comprehensive and compassionate genetic counseling to women with sickle cell anemia contemplating pregnancy, discussing risks, available interventions, and reproductive options. Establish ethical guidelines or committees to assist healthcare providers in navigating the ethical complexities surrounding treatment decisions during pregnancy in this population. Improve access to specialized healthcare services for pregnant women with sickle cell anemia, particularly in regions with limited resources or healthcare disparities. Provide psychosocial support and resources for expectant mothers to address the emotional and mental health aspects associated with managing a chronic condition during pregnancy. Conduct longitudinal studies to assess the long-term health outcomes for both mothers and children born to women with sickle cell anemia who experienced hemolysis during pregnancy. Monitor the impact of hemolysis and associated interventions on the overall health and well-being of mothers and offspring beyond the immediate postpartum period. Implementing these recommendations requires collaboration among healthcare providers, policymakers, researchers, patient advocacy groups, and affected individuals to improve the care and outcomes of pregnant women grappling with hemolysis in the setting of sickle cell anemia. These measures aim to address the challenges and gaps in current practices and promote enhanced care tailored to the unique needs of this vulnerable population.

CONCLUSION

The management of hemolysis in expectant mothers with sickle cell anemia poses intricate challenges requiring a comprehensive and nuanced approach. Understanding the pathophysiology, implementing best practices, and navigating the associated challenges are crucial to optimize maternal and fetal outcomes. However, managing hemolysis in this population is fraught with challenges, including limited empirical data, ethical dilemmas, and complexities in balancing maternal and fetal health needs. These challenges underscore the need for further research, the development of evidence-based guidelines, and ethical considerations to guide clinical decision-making.

Moving forward, concerted efforts among healthcare professionals, researchers, policymakers, and advocacy groups are imperative to advance the care of pregnant women with sickle cell anemia experiencing hemolysis. Through collaborative endeavors, improved access to care, further research initiatives, and the development of clear guidelines, the goal of optimizing outcomes for this vulnerable population can be achieved. Ultimately, a holistic approach that integrates clinical expertise, patient-centered care, ongoing research, and ethical considerations is pivotal in effectively navigating hemolysis in expectant mothers with sickle cell anemia, ensuring the best possible outcomes for both mother and child.

REFERENCES

1. Obeagu EI, Ochei KC, Nwachukwu BN, Nchuma BO. Sickle cell anaemia: a review. Scholars Journal of Applied Medical Sciences. 2015;3(6B):2244-52.
2. Obeagu EI. Erythropoeitin in Sickle Cell Anaemia: A Review. International Journal of Research Studies in Medical and Health Sciences. 2020;5(2):22-8.
3. Obeagu EI. Sickle Cell Anaemia: Haemolysis and Anemia. Int. J. Curr. Res. Chem. Pharm. Sci. 2018;5(10):20-1.
4. Obeagu EI, Muhimbura E, Kagenderezo BP, Uwakwe OS, Nakyeyune S, Obeagu GU. An Update on Interferon Gamma and C Reactive Proteins in Sickle Cell Anaemia Crisis. J Biomed Sci. 2022;11(10):84.
5. Obeagu EI, Bunu UO, Obeagu GU, Habimana JB. Antioxidants in the management of sickle cell anaemia: an area to be exploited for the wellbeing of the patients. International Research in Medical and Health Sciences. 2023;6(4):12-7.
6. Obeagu EI, Ogunnaya FU, Obeagu GU, Ndidi AC. Sickle cell anaemia: a gestational enigma. European Journal of Biomedical and Pharmaceutical Sciences. 2023;10((9): 72-75
7. Obeagu EI. An update on micro RNA in sickle cell disease. Int J Adv Res Biol Sci. 2018; 5:157-8.
8. Obeagu EI, Babar Q. Covid-19 and Sickle Cell Anemia: Susceptibility and Severity. J. Clinical and Laboratory Research. 2021;3(5):2768-0487.
9. Obeagu EI, Obeagu GU, Igwe MC, Alum EU, Ugwu OP. Men's Essential roles in the Management of Sickle Cell Anemia. NEWPORT INTERNATIONAL JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES, 2023 4(2):20-29. https://doi.org/10.59298/NIJSES/2023/10.3.1111
10. Obeagu EI. Depression in Sickle Cell Anemia: An Overlooked Battle. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(10):41-.
11. Obeagu EI, Obeagu GU Evaluation of Hematological Parameters of Sickle Cell

Anemia Patients with Osteomyelitis in A Tertiary Hospital in Enugu, Nigeria. Journal of Clinical and Laboratory Research. 2023; 6(1):2768-0487.
12. Obeagu EI, Agreen FC. Anaemia among pregnant women: A review of African pregnant teenagers. J Pub Health Nutri. 2023; 6 (1). 2023;138. links/63da799664fc860638054562/Anaemia-among-pregnant-women-A-review-of-African-pregnant-teenagers.pdf.
13. Obeagu EI, Ezimah AC, Obeagu GU. Erythropoietin in the anaemias of pregnancy: a review. Int J Curr Res Chem Pharm Sci. 2016;3(3):10-8. links/5710fae108ae846f4ef05afb/ERYTHROPOIETIN-IN-THE-ANAEMIAS-OF-PREGNANCY-A-REVIEW.pdf.
14. Obeagu EI, Adepoju OJ, Okafor CJ, Obeagu GU, Ibekwe AM, Okpala PU, Agu CC. Assessment of Haematological Changes in Pregnant Women of Ido, Ondo State, Nigeria. J Res Med Dent Sci. 2021;9(4):145-8. links/608a6728a6fdccaebdf52d94/Assessment-of-Haematological-Changes-in-Pregnant-Women-of-Ido-Ondo.pdf.
15. Obeagu EI, Obeagu GU. Sickle Cell Anaemia in Pregnancy: A Review. International Research in Medical and Health Sciences. 2023;6(2):10-3. http://irmhs.com/index.php/irmhs/article/view/111.
16. Jakheng SP, Obeagu EI. Seroprevalence of human immunodeficiency virus based on demographic and risk factors among pregnant women attending clinics in Zaria Metropolis, Nigeria. J Pub Health Nutri. 2022; 5 (8). 2022;137. links/6317a6b1acd814437f0ad268/Seroprevalence-of-human-immunodeficiency-virus-based-on-demographic-and-risk-factors-among-pregnant-women-attending-clinics-in-Zaria-Metropolis-Nigeria.pdf.
17. Obeagu EI, Obeagu GU, Chukwueze CM, Ikpenwa JN, Ramos GF. Evaluation of Protein C, Protein S and Fibrinogen of Pregnant Women with Malaria in Owerri Metropolis. Madonna University journal of Medicine and Health Sciences ISSN: 2814-3035. 2022;2(2):1-9.
18. Obeagu EI, Ikpenwa JN, Chukwueze CM, Obeagu GU. Evaluation of protein C, protein S and fibrinogen of pregnant women in Owerri Metropolis. Madonna University Journal of Medicine and Health Sciences. 2022;2(1):292-8. https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/57.
19. Obeagu EI, Obeagu GU, Adepoju OJ. Evaluation of haematological parameters of pregnant women based on age groups in Olorunsogo road area of Ido, Ondo state. J. Bio. Innov 11 (3). 2022:936-41.
20. Obeagu EI. An update on utilization of antenatal care among pregnant Women in Nigeria. Int. J. Curr. Res. Chem. Pharm. Sci. 2022;9(9):21-6.DOI: 10.22192/ijcrcps.2022.09.09.003
21. Okoroiwu IL, Obeagu EI, Obeagu GU. Determination of clot retraction in preganant women attending antenatal clinic in federal medical centre Owerri, Nigeria. Madonna University Journal of Medicine and Health Sciences ISSN: 2814-3035. 2022;2(2):91-7. https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/67.
22. Obeagu EI, Dahir FS, Francisca U, Vandu C, Obeagu GU. Hyperthyroidism in sickle cell anaemia. Int. J. Adv. Res. Biol. Sci. 2023;10(3):81-9.
23. Obeagu EI, Obeagu GU, Akinleye CA, Igwe MC. Nosocomial infections in sickle cell anemia patients: Prevention through multi-disciplinary approach: A review. Medicine. 2023;102(48): e36462.
24. Njar VE, Ogunnaya FU, Obeagu EI. Knowledge And Prevalence of The Sickle Cell Trait Among Undergraduate Students Of The University Of Calabar. Prevalence.;5(100):0-5.
25. Swem CA, Ukaejiofo EO, Obeagu EI, Eluke B. Expression of micro RNA 144 in sickle cell disease. Int. J. Curr. Res. Med. Sci. 2018;4(3):26-32.
26. Obeagu EI, Nimo OM, Bunu UO, Ugwu OP, Alum EU. Anaemia in children under five years: African perspectives. Int. J. Curr. Res. Biol. Med. 2023; 1:1-7.
27. Obeagu EI. Sickle cell anaemia: Historical perspective, Pathophysiology and Clinical manifestations. Int. J. Curr. Res. Chem. Pharm. Sci. 2018;5(11):13-5.
28. Obeagu EI, Obeagu GU. Sickle Cell Anaemia in Pregnancy: A Review. International Research in Medical and Health Sciences. 2023;6(2):10-3.
29. Obeagu EI, Mohamod AH. An update on Iron deficiency anaemia among children with congenital heart disease. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(4):45-8.
30. Edward U, Osuorji VC, Nnodim J, Obeagu EI. Evaluationof Trace Elements in Sickle

Cell Anaemia Patients Attending Imo State Specialist Hospital, Owerri. Madonna University journal of Medicine and Health Sciences. 2022 ;2(1):218-34.
31. Umar MI, Aliyu F, Abdullahi MI, Aliyu MN, Isyaku I, Aisha BB, Sadiq RU, Shariff MI, Obeagu EI. ASSESSMENT OF FACTORS PRECIPITATING SICKLE CELL CRISES AMONG UNDER 5-YEARS CHILDREN ATTENDING SICKLE CELL CLINIC OF MURTALA MUHAMMAD SPECIALIST HOSPITAL, KANO. blood.;11:16.
32. Obeagu EI. Vaso-occlusion and adhesion molecules in sickle cells disease. Int J Curr Res Med Sci. 2018;4(11):33-5.
33. Ifeanyi OE, Stella EI, Favour AA. Antioxidants In the Management of Sickle Cell Anaemia. Int J Hematol Blood Disord (Internet) 2018 (cited 2021 Mar 4); 3. Available from: https://symbiosisonlinepublishing. com/hematology/hema tology25. php. 2018 Sep.
34. Buhari HA, Ahmad AS, Obeagu EI. Current Advances in the Diagnosis and Treatment of Sickle Cell Anaemia. APPLIED SCIENCES (NIJBAS). 2023;4(1).
35. Nnodim J, Uche U, Ifeoma U, Chidozie N, Ifeanyi O, Oluchi AA. Hepcidin and erythropoietin level in sickle cell disease. British Journal of Medicine and Medical Research. 2015;8(3):261-5.
36. Obeagu EI. BURDEN OF CHRONIC OSTEOMYLITIS: REVIEW OF ASSOCIATIED FACTORS. Madonna University journal of Medicine and Health Sciences ISSN: 2814-3035. 2023;3(1):1-6.
37. Aloh GS, Obeagu EI, Okoroiwu IL, Odo CE, Chibunna OM, Kanu SN, Elemchukwu Q, Okpara KE, Ugwu GU. Antioxidant-Mediated Heinz Bodies Levels of Sickle Erythrocytes under Drug-Induced Oxidative Stress. European Journal of Biomedical and Pharmaceutical sciences. 2015;2(1):502-7.
38. Obeagu EI, Malot S, Obeagu GU, Ugwu OP. HIV resistance in patients with Sickle Cell Anaemia. Newport International Journal of Scientific and Experimental Sciences (NIJSES). 2023;3(2):56-9.
39. Obeagu EI, Bot YS, Opoku D, Obeagu GU, Hassan AO. Sickle Cell Anaemia: Current Burden in Africa. International Journal of Innovative and Applied Research. 2023;11(2):12-4.
40. Obeagu EI, Obeagu GU. Sickle Cell Anaemia in Pregnancy: A Review. International Research in Medical and Health Sciences. 2023; 6 (2): 10-3.
41. Obeagu EI, Ogbuabor BN, Ikechukwu OA, Chude CN. Haematological parameters among sickle cell anemia patients' state and haemoglobin genotype AA individuals at Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. International Journal of Current Microbiology and Applied Sciences. 2014;3(3):1000-5.
42. Ifeanyi OE, Nwakaego OB, Angela IO, Nwakaego CC. Haematological parameters among sickle cell anaemia... Emmanuel Ifeanyi1, et al. pdf• Obeagu. Int. J. Curr. Microbiol. App. Sci. 2014;3(3):1000-5.
43. Obeagu EI, Abdirahman BF, Bunu UO, Obeagu GU. Obsterics characteristics that effect the newborn outcomes. Int. J. Adv. Res. Biol. Sci. 2023;10(3):134-43.
44. Obeagu EI, Opoku D, Obeagu GU. Burden of nutritional anaemia in Africa: A Review. Int. J. Adv. Res. Biol. Sci. 2023;10(2):160-3.
45. Ifeanyi E. Erythropoietin (Epo) Level in Sickle Cell Anaemia (HbSS) With Falciparum Malaria Infection in University Health Services, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. PARIPEX - INDIAN JOURNAL OF RESEARCH, 2015; 4(6): 258-259
46. Ifeanyi OE, Nwakaego OB, Angela IO, Nwakaego CC. Haematological parameters among sickle cell anaemia patients in steady state and haemoglobin genotype AA individuals at Michael Okpara, University of Agriculture, Umudike, Abia State, Nigeria. Int. J. Curr. Microbiol. App. Sci. 2014;3(3):1000-5.
47. Ifeanyi OE, Stanley MC, Nwakaego OB. Comparative analysis of some haematological parameters in sickle cell patients in steady and crisis state at michael okpara University of agriculture, Umudike, Abia state, Nigeria. Int. J. Curr. Microbiol. App. Sci. 2014;3(3):1046-50.
48. Ifeanyi EO, Uzoma GO. Malaria and The Sickle Cell Trait: Conferring Selective Protective Advantage to Malaria. J Clin Med Res. 2020; 2:1-4.
49. Lei H, Karniadakis GE. Quantifying the rheological and hemodynamic characteristics of sickle cell anemia. Biophysical journal. 2012;102(2):185-94.
50. Obeagu EI, Hassan AO, Adepoju OJ, Obeagu GU, Okafor CJ. Evaluation of Changes in Haematological Parameters of Pregnant Women Based on Gestational Age at Olorunsogo Road Area of Ido, Ondo State.

Nigeria. Journal of Research in Medical and Dental Science. 2021;9(12):462-.links/61b1e32f0c4bfb675178bfa7/Evaluation-of-Changes-in-Haematological-Parameters-of-Pregnant-Women-Based-on-Gestational-Age-at-Olorunsogo-Road-Area-of-Ido-Ondo-State-Nigeria.pdf.

51. Anyiam AF, Obeagu EI, Obi E, Omosigho PO, Irondi EA, Arinze-Anyiam OC, Asiyah MK. ABO blood groups and gestational diabetes among pregnant women attending University of Ilorin Teaching Hospital, Kwara State, Nigeria. International Journal of Research and Reports in Hematology. 2022;5(2):113-21.
52. Obeagu EI. Gestational Thrombocytopaenia. J Gynecol Women's Health. 2023;25(3):556163. links/64b01aa88de7ed28ba95fccb/Gestational-Thrombocytopaenia.pdf.
53. Jakheng SP, Obeagu EI, Abdullahi IO, Jakheng EW, Chukwueze CM, Eze GC, Essien UC, Madekwe CC, Madekwe CC, Vidya S, Kumar S. Distribution Rate of Chlamydial Infection According to Demographic Factors among Pregnant Women Attending Clinics in Zaria Metropolis, Kaduna State, Nigeria. South Asian Journal of Research in Microbiology. 2022;13(2):26-31.
54. Obeagu EI, Ogbonna US, Nwachukwu AC, Ochiabuto O, Enweani IB, Ezeoru VC. Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha, Nigeria. Journal of Pharmaceutical Research International. 2021;33(4):10-9.
55. Obeagu EI, Abdirahman BF, Bunu UO, Obeagu GU. Obsterics characteristics that effect the newborn outcomes. Int. J. Adv. Res. Biol. Sci. 2023;10(3): 134-43.DOI: 10.22192/ijarbs.2023.10.03.016
56. Obeagu EI, Ogunnaya FU. PREGNANCYINDUCED HAEMATOLOGICAL CHANGES: A KEY TO MARTERNAL AND CHILD HEALTH. European Journal of Biomedical. 2023;10(8):42-3. links/64c890bddb38b20d6dad2c5c/PREGNANCY-INDUCED-HAEMATOLOGICAL-CHANGES-A-KEY-TO-MARTERNAL-AND-CHILD-HEALTH.pdf.
57. Ezeoru VC, Enweani IB, Ochiabuto O, Nwachukwu AC, Ogbonna US, Obeagu EI. Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha, Nigeria. Journal of Pharmaceutical Research International. 2021;33(4):10-9.
58. Okamgba OC, Nwosu DC, Nwobodo EI, Agu GC, Ozims SJ, Obeagu EI, Ibanga IE, Obioma-Elemba IE, Ihekaire DE, Obasi CC, Amah HC. Iron Status of Pregnant and Post-Partum Women with Malaria Parasitaemia in Aba Abia State, Nigeria. Annals of Clinical and Laboratory Research. 2017;5(4):206. links/5ea97df145851592d6a8acf2/Iron-Status-of-Pregnant-and-Post-Partum-Women-with-Malaria-Parasitaemia-in-Aba-Abia-State-Nigeria.pdf.
59. Eze RI, Obeagu EI, Edet FN. Frequency of Rh Antigen C And c among pregnant women in Sub-Urban area in Eastern Nigeria. Madonna Uni J Med Health Sci. 2021;1(1):19-30.
60. Obeagu EI, Ofodile AC, Okwuanaso CB. A review of urinary tract infections in pregnant women: Risks factors. J Pub Health Nutri. 2023; 6 (1). 2023;137:26-35. links/63c3a9116fe15d6a571e8bba/A-review-of-urinary-tract-infections-in-pregnant-women-Risks-factors.pdf.
61. Obeagu EI, Obeagu GU, Musiimenta E. Post partum haemorrhage among pregnant women: Update on risks factors. Int. J. Curr. Res. Med. Sci. 2023;9(2): 14-7.DOI: 10.22192/ijcrms.2023.09.02.003
62. Obeagu EI, Obeagu GU, Ogunnaya FU. Deep vein thrombosis in pregnancy: A review of prevalence and risk factors. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(8): 14-21.DOI: 10.22192/ijcrcps.2023.10.08.002
63. Jakheng SP, Obeagu EI, Jakheng EW, Uwakwe OS, Eze GC, Obeagu GU, Vidya S, Kumar S. Occurrence of Chlamydial Infection Based on Clinical Symptoms and Clinical History among Pregnant Women Attending Clinics in Zaria Metropolis, Kaduna State, Nigeria. International Journal of Research and Reports in Gynaecology. 2022;5(3):98-105.
64. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA. Assessment of some haematological parameters in malaria infected pregnant women in Imo state Nigeria. Int. J. Curr. Res. Biol. Med. 2018;3(9): 1-4.DOI: 10.22192/ijcrbm.2018.03.09.001
65. Onyenweaku FC, Amah HC, Obeagu EI, Nwandikor UU, Onwuasoanya UF. Prevalence of asymptomatic bacteriuria and its antibiotic susceptibility pattern in pregnant women attending private ante natal clinics in Umuahia Metropolitan. Int J

Curr Res Biol Med. 2017;2(2): 13-23.DOI: 10.22192/ijcrbm.2017.02.02.003

66. Okoroiwu IL, Chinedu-Madu JU, Obeagu EI, Vincent CC, Ochiabuto OM, Ibekwe AM, Amaechi CO, Agu CC, Anoh NV, Amadi NM. Evaluation of Iron Status, Haemoglobin and Protein Levels of Pregnant Women in Owerri Metropolis. Journal of Pharmaceutical Research International. 2021;33(27A):36-43.
67. Obeagu EI, Njar VE, Obeagu GU. Infertility: Prevalence and Consequences. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(7):43-50.
68. Emeka-Obi OR, Ibeh NC, Obeagu EI, Okorie HM. Evaluation of levels of some inflammatory cytokines in preeclamptic women in owerri. Journal of Pharmaceutical Research International. 2021;33(42A):53-65.
69. Obeagu EI, Faduma MH, Uzoma G. Ectopic Pregnancy: A Review. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(4):40-4.DOI: 10.22192/ijcrcps.2023.10.04.004
70. Obeagu EI, Gamade SM, Obeagu GU. The roles of Neutrophils in pregnancy. Int. J. Curr. Res. Med. Sci. 2023;9(5): 31-5.DOI: 10.22192/ijcrms.2023.09.05.005
71. Eze R, Obeagu EI, Nwakulite A, Okoroiwu IL, Vincent CC, Okafor CJ, Chukwurah EF, Chijioke UO, Amaechi CO. Evaluation of Copper Status and Some Red Cell Parameters of Pregnant Women in Enugu State, South Eastern Nigeria. Journal of Pharmaceutical Research International. 2021;33(30A):67-71.
72. Obeagu EI, Obeagu GU. Molar Pregnancy: Update of prevalence and risk factors. Int. J. Curr. Res. Med. Sci. 2023;9(7): 25-8.DOI: 10.22192/ijcrms.2023.09.07.005
73. Obeagu EI, Bunu UO. Factors that influence unmet need for family planning. International Journal of Current Research in Biology and Medicine. 2023;8(1):23-7.
74. Ibebuike JE, Ojie CA, Nwokike GI, Obeagu EI, Nwosu DC, Nwanjo HU, Agu GC, Ezenwuba CO, Nwagu SA, Akujuobi AU. Barriers to utilization of maternal health services in southern senatorial district of Cross Rivers state, Nigeria. International Journal of Advanced Multidisciplinary Research. 2017;4(8): 1-9.DOI: 10.22192/ijamr.2017.04.08.001
75. Emannuel G, Martin O, Peter OS, Obeagu EI, Daniel K. Factors Influencing Early Neonatal Adverse Outcomes among Women with HIV with Post Dated Pregnancies Delivering at Kampala International University Teaching Hospital, Uganda. Asian Journal of Pregnancy and Childbirth. 2023;6(1):203-11. http://research.sdpublishers.net/id/eprint/2819/.
76. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA. Assessment of coagulation parameters in malaria infected pregnant women in Imo state, Nigeria. International Journal of Current Research in Medical Sciences. 2018;4(9): 41-9.DOI: 10.22192/ijcrms.2018.04.09.006
77. Obeagu EI, Obeagu GU. Postpartum haemorrhage among women delivering through spontaneous vaginal delivery: Prevalence and risk factors. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(8):22-6.DOI: 10.22192/ijcrcps.2023.10.08.003
78. Obeagu E, Eze RI, Obeagu EI, Nnatuanya IN, Dara EC. ZINC LEVEL IN APPARENTLY PREGNANT WOMEN IN URBAN AREA. Madonna University journal of Medicine and HealthSciences.2022;2(1):134-48. https://www.journal.madonnauniversity.edu.ng/index.php/medicine/article/view/40.
79. Ogomaka IA, Obeagu EI. Malaria in Pregnancy Amidst Possession of Insecticide Treated Bed Nets (ITNs) in Orlu LGA of Imo State, Nigeria. Journal of Pharmaceutical Research International. 2021;33(41B):380-6.
80. Obeagu EI, Ogunnaya FU, Obeagu GU, Ndidi AC. SICKLE CELL ANAEMIA: A GESTATIONAL ENIGMA. migration. 2023; 17:18.
81. Ifeanyi OE, Uzoma OG. A review on erythropietin in pregnancy. J. Gynecol. Womens Health.2018;8(3):1-4. https://www.academia.edu/download/56538560/A_Review_on_Erythropietin_in_Pregnancy.pdf.
82. Ifeanyi OE. A review on pregnancy and haematology. Int. J. Curr. Res. Biol. Med. 2018;3(5): 26-8.DOI: 10.22192/ijcrbm.2018.03.05.006
83. Nwosu DC, Nwanjo HU, Obeagu EI, Ibebuike JE, Ezeama MC. Ihekireh. Changes in liver enzymes and lipid profile of pregnant women with malaria in Owerri, Nigeria. International Journal of Current Research and Academic Review. 2015;3(5):376-83.
84. Ibebuike JE, Ojie CA, Nwokike GI, Obeagu EI, Nwosu DC, Nwanjo HU, Agu GC, Ezenwuba CO, Nwagu SA, Akujuobi AU. Factors that influence women's utilization of primary health care services in Calabar Cros

river state, Nigeria. Int. J. Curr. Res. Chem. Pharm. Sci. 2017;4(7):28-33.
85. Eze R, Ezeah GA, Obeagu EI, Omeje C, Nwakulite A. Evaluation of iron status and some haematological parameters of pregnant women in Enugu, South Eastern Nigeria. World Journal of Pharmaceutical and Medical Research. 2021;7(5):251-4.
86. Elemchukwu Q, Obeagu EI, Ochei KC. Prevalence of Anaemia among Pregnant Women in Braithwaite Memorial Specialist Hospital (BMSH) Port Harcourt. IOSR Journal of Pharmacy and Biological Sciences. 2014;9(5):59-64.
87. Akandinda M, Obeagu EI, Katonera MT. Non Governmental Organizations and Women's Health Empowerment in Uganda: A Review. Asian Research Journal of Gynaecology and Obstetrics. 2022 Dec 14;8(3):12-6.
88. Vidya S. Sunil Kumar Shango Patience Emmanuel Jakheng, Emmanuel Ifeanyi Obeagu, Emmanuel William Jakheng, Onyekachi Splendid Uwakwe, Gloria Chizoba Eze, and Getrude Uzoma Obeagu (2022). Occurrence of Chlamydial Infection Based on Clinical Symptoms and Clinical History among Pregnant Women Attending Clinics in Zaria Metropolis, Kaduna State, Nigeria. International Journal of Research and Reports in Gynaecology.;5(3):98-105.
89. Mishra P. Treatment of sickle cell disease: Beyond hydroxyurea. Journal of Hematology and Allied Sciences. 2022;1(3):93-8.
90. Gamde MS, Obeagu EI. IRON DEFICIENCY ANAEMIA: ENEMICAL TO PREGNANCY. European Journal of Biomedical. 2023;10(9):272-5. links/64f63358827074313ffaae7b/IRON-DEFICIENCY-ANAEMIA-ENEMICAL-TO-PREGNANCY.pdf.
91. Emeka-Obi OR, Ibeh NC, Obeagu EI, Okorie HM. Evaluation of levels of some inflammatory cytokines in preeclamptic women in owerri. Journal of Pharmaceutical Research International. 2021;33(42A):53-65.
92. Emeka-Obi OR, Ibeh NC, Obeagu EI, Okorie HM. Studies of Some Haemostatic Variables in Preeclamptic Women in Owerri, Imo State, Nigeria. Journal of Pharmaceutical Research International. 2021;33(42B):39-48.
93. Obeagu EI, Obeagu GU. Postpartum haemorrhage among women delivering through spontaneous vaginal delivery: Prevalence and risk factors. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(8):22-6.
94. Obeagu EI, Obeagu GU. Sickle Cell Anaemia in Pregnancy: A Review. International Research in Medical and Health Sciences. 2023;6(2):10-3.
95. Davis BA, Allard S, Qureshi A, Porter JB, Pancham S, Win N, Cho G, Ryan K, British Society for Haematology. Guidelines on red cell transfusion in sickle cell disease Part II: indications for transfusion. British journal of haematology. 2017;176(2):192-209.
96. Chock VY, Davis AS, Hintz SR. The roles and responsibilities of the neonatologist in complex fetal medicine: providing a continuum of care. Neoreviews. 2015;16(1): e9-15.
97. Darbari DS, Sheehan VA, Ballas SK. The vaso-occlusive pain crisis in sickle cell disease: definition, pathophysiology, and management. European journal of haematology. 2020(3):237-46.
98. James AH, Strouse JJ. How We Treat Sickle Cell Disease in Pregnancy. Blood. 2023.
99. McKiever M, Frey H, Costantine MM. Challenges in conducting clinical research studies in pregnant women. Journal of pharmacokinetics and pharmacodynamics. 2020; 47:287-93.
100. Costa VM, Viana MB, Aguiar RA. Pregnancy in patients with sickle cell disease: maternal and perinatal outcomes. The Journal of Maternal-Fetal & Neonatal Medicine. 2015;28(6):685-9.

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