Elite Journal of Laboratory Medicine. Volume 2 issue 1(2024), Pp. 1-13
https://epjournals.com/journals/EJLM

A Critical Appraisal of Erythropoietin Levels in HIV: Clinical Relevance

*Emmanuel Ifeanyi Obeagu[1] and Getrude Uzoma Obeagu[2]

[1]Department of Medical Laboratory Science, Kampala International University, Uganda.

[2]School of Nursing Science, Kampala International University, Uganda.

*Corresponding authour: Emmanuel Ifeanyi Obeagu, Department of Medical Laboratory Science, Kampala International University, Uganda, emmanuelobeagu@yahoo.com, ORCID: 0000-0002-4538-0161

Abstract

This review critically evaluates the intricate relationship between erythropoietin levels and HIV infection, shedding light on its clinical relevance, particularly in the context of anemia and hematopoiesis. Erythropoietin, a key regulator of red blood cell production, plays a pivotal role in maintaining hematological homeostasis. In individuals living with HIV, alterations in erythropoietin levels are frequently observed, impacting not only the course of anemia but also reflecting the intricate interplay between viral pathogenesis and hematopoiesis. Through a comprehensive examination of existing literature, this review aims to provide insights into the clinical implications of erythropoietin dynamics in HIV, offering a foundation for further research and targeted therapeutic interventions.

Keywords: Erythropoietin, HIV, Anemia, Hematopoiesis, Inflammation, Clinical Implications

Introduction

Human Immunodeficiency Virus (HIV) infection continues to be a global health challenge, impacting millions of lives worldwide. Beyond its well-established effects on the immune system, HIV infection is associated with a range of hematological abnormalities, including anemia. Erythropoietin, a glycoprotein hormone crucial for red blood cell production, has emerged as a key player in the intricate interplay between HIV and hematopoiesis. This review critically appraises the clinical relevance of erythropoietin levels in individuals living with HIV, aiming to unravel the complexities that surround its role in HIV pathogenesis, clinical management, and

Citation: Obeagu EI, Obeagu GU. **A Critical Appraisal of Erythropoietin Levels in HIV: Clinical Relevance**. Elite Journal of Laboratory Medicine, 2024; 2(1): 1-13

potential as a biomarker for disease progression.[1-18] Erythropoiesis, the process of red blood cell formation, is intricately regulated by erythropoietin. Released primarily by the kidneys in response to hypoxia, erythropoietin stimulates the proliferation and differentiation of erythroid progenitor cells in the bone marrow. The dysregulation of this tightly controlled system is frequently observed in chronic diseases, including HIV, leading to anemia, which is a common hematological complication in individuals living with the virus.[19-23]

HIV infection induces hematological alterations through various mechanisms, impacting multiple cell lineages, including erythrocytes. Anemia is a frequent hematological complication in HIV, with multifactorial causes, including impaired erythropoiesis, increased red blood cell destruction, and inflammatory cytokine-mediated effects. Understanding the role of erythropoietin in this complex milieu is pivotal for unraveling the pathophysiology and devising targeted interventions. Erythropoietin levels have shown promise as potential biomarkers in HIV management. Elevated or suppressed erythropoietin levels may reflect underlying hematological complications, disease progression, or response to antiretroviral therapy (ART). This section critically examines the current evidence supporting the utility of erythropoietin as a biomarker and explores its potential in guiding clinical decision-making.[24-43] The administration of exogenous erythropoietin or erythropoiesis-stimulating agents has been explored as a therapeutic strategy to address HIV-related anemia. However, the clinical benefits, potential risks, and challenges associated with this approach require careful consideration. The review discusses the existing evidence and controversies surrounding erythropoietin-based interventions in the context of HIV.

Erythropoietin Regulation and Function

Erythropoietin (EPO) is a glycoprotein hormone crucial for the regulation of red blood cell production, a process known as erythropoiesis. EPO is primarily produced by peritubular interstitial cells in the renal cortex and, to a lesser extent, by hepatocytes in the liver. The synthesis of EPO is regulated by the oxygen-sensing mechanism, predominantly mediated by hypoxia-inducible factor (HIF). Under hypoxic conditions, HIF accumulates, leading to increased EPO gene transcription. This hypoxic response is pivotal for EPO release, ensuring an appropriate erythropoietic response to low oxygen levels. The oxygen-sensing mechanism involves the prolyl hydroxylase (PHD) enzymes, which hydroxylate specific proline residues on HIF. Under normoxic conditions, hydroxylated HIF is targeted for ubiquitin-proteasomal degradation. In hypoxia, PHD activity is inhibited, allowing HIF to accumulate, translocate to the nucleus, and initiate the transcription of EPO and other hypoxia-responsive genes. This sophisticated regulatory system ensures that EPO production is finely tuned to oxygen demands.[44-67]

EPO exerts its primary function in the bone marrow, where it binds to EPO receptors on the surface of erythroid progenitor cells. This interaction stimulates the proliferation and differentiation of these progenitor cells into mature erythrocytes. EPO also plays a role in regulating the lifespan of circulating red blood cells by inhibiting apoptosis in erythrocyte precursors. Beyond its classical role in erythropoiesis, EPO has been recognized for its pleiotropic effects on various tissues and organ systems. EPO receptors are expressed in non-erythroid cells, including endothelial cells,

neurons, and immune cells. EPO has been implicated in neuroprotection, angiogenesis, tissue repair, and modulation of immune responses. The diverse functions of EPO beyond erythropoiesis underscore its potential as a therapeutic agent in conditions beyond anemia. Recombinant human EPO (rhEPO) has found extensive clinical applications, particularly in the management of anemia associated with chronic kidney disease, cancer chemotherapy, and HIV. The administration of rhEPO aims to stimulate erythropoiesis and alleviate anemia in various clinical settings. However, careful consideration of potential risks, including thromboembolic events and hypertension, is essential in therapeutic decision-making.[68-79]

Erythropoietin Levels in HIV-Associated Anemia

HIV infection is frequently accompanied by hematological complications, with anemia being a common manifestation. The regulation of EPO in the context of HIV is a dynamic process influenced by various factors. HIV infection itself, as well as the associated inflammatory response, contributes to alterations in EPO synthesis and release. Chronic immune activation, cytokine dysregulation, and direct viral effects on the bone marrow collectively impact the erythropoietic response, leading to dysregulation of EPO levels. EPO levels in individuals with HIV have been explored as potential biomarkers for disease progression. Changes in EPO levels may reflect the severity of anemia, the degree of bone marrow suppression, and the overall impact of HIV on erythropoiesis. Monitoring EPO levels alongside traditional markers provides a more comprehensive understanding of the hematological dynamics in HIV-infected individuals.[80-89]

The severity of anemia in HIV correlates with EPO levels, highlighting the potential utility of EPO as a marker for the degree of erythropoietic response.[90] Understanding the relationship between EPO and anemia severity is crucial for tailoring therapeutic interventions. Elevated EPO levels may suggest an appropriate erythropoietic response to anemia, while persistently low levels may indicate a compromised erythropoietic capacity. Initiation of antiretroviral therapy (ART) in HIV-infected individuals can influence EPO levels and erythropoiesis. Effective viral suppression with ART has been associated with improvements in anemia, potentially influencing EPO dynamics. However, the complex interplay between ART, immune reconstitution, and the restoration of erythropoiesis requires further investigation to delineate the nuanced effects on EPO levels. Given the role of EPO in erythropoiesis, understanding its levels in HIV-associated anemia has therapeutic implications. The administration of exogenous EPO or erythropoiesis-stimulating agents may be considered to address anemia in HIV-infected individuals, particularly in cases where EPO levels are suboptimal. However, the potential risks, including cardiovascular complications, must be carefully weighed against the benefits.

Implications for Hematopoiesis and Disease Progression

Understanding the implications of erythropoietin (EPO) levels in HIV-associated anemia extends beyond the confines of hematopoiesis, offering insights into the broader landscape of disease progression and clinical outcomes. EPO levels in HIV-associated anemia serve as a barometer of disease severity, offering clinicians a valuable tool to gauge the impact of viral infection on

hematopoiesis. Elevated EPO levels may signify an appropriate response to anemia, reflecting the bone marrow's attempt to compensate for red blood cell loss. Conversely, persistently low EPO levels may indicate compromised erythropoietic capacity, potentially linked to the severity of HIV-induced bone marrow suppression.[92] HIV infection is known to induce bone marrow suppression, affecting multiple hematopoietic lineages, including erythrocytes. Dysregulation of EPO in this context further exacerbates erythropoietic dysfunction. Understanding the nuances of EPO dynamics provides crucial insights into the extent of bone marrow involvement, offering potential prognostic value in predicting the trajectory of anemia and disease progression.

The relationship between EPO levels and immune status in HIV-infected individuals is complex. Chronic immune activation and inflammation associated with HIV can influence EPO synthesis and release.[93] Elevated EPO levels may reflect not only the severity of anemia but also the systemic inflammatory response. This interplay underscores the interconnectedness of hematopoiesis and immune function in the context of HIV. Monitoring EPO levels may hold predictive value for treatment outcomes in HIV-associated anemia. Changes in EPO dynamics during antiretroviral therapy (ART) may offer insights into the effectiveness of viral suppression and immune reconstitution. Successful restoration of immune function and erythropoiesis may coincide with normalization of EPO levels, providing a potential indicator of treatment response. The implications of EPO dynamics extend to therapeutic decision-making in the management of HIV-associated anemia. Elevated or suppressed EPO levels may guide the choice between supportive measures, such as blood transfusions, and interventions aimed at stimulating erythropoiesis, including the administration of exogenous EPO or erythropoiesis-stimulating agents. Tailoring therapeutic strategies based on EPO dynamics contributes to a more personalized approach to anemia management.

Therapeutic Considerations

The therapeutic considerations surrounding erythropoietin (EPO) in the context of HIV-associated anemia are multifaceted and demand a nuanced approach. The administration of exogenous EPO or erythropoiesis-stimulating agents (ESAs) stands as a therapeutic option to address anemia in individuals with HIV. By augmenting erythropoiesis, exogenous EPO aims to improve hemoglobin levels and alleviate anemia-related symptoms. This approach may be particularly beneficial in cases where endogenous EPO production is insufficient or compromised due to HIV-induced bone marrow suppression.[94] Tailoring therapeutic decisions based on the individual's EPO levels is a critical consideration. Elevated EPO levels may suggest an appropriate erythropoietic response, while persistently low levels may indicate a compromised bone marrow function. This nuanced approach allows clinicians to selectively target individuals who are likely to benefit from exogenous EPO administration, optimizing the therapeutic response.

The initiation and optimization of antiretroviral therapy (ART) play a pivotal role in managing HIV-associated anemia. Successful viral suppression and immune reconstitution through ART can contribute to the restoration of erythropoiesis. Understanding the interplay between ART, viral dynamics, and EPO levels is essential for maximizing therapeutic outcomes and mitigating

anemia-related complications. While exogenous EPO administration can improve anemia, it is not without risks. Cardiovascular complications, including thromboembolic events and hypertension, have been associated with EPO therapy. Careful monitoring of cardiovascular parameters, including blood pressure and clotting profiles, is imperative during EPO treatment. Risk stratification and individualized treatment plans are crucial to balance the potential benefits and risks.[94]

Therapeutic considerations must account for patient-specific factors, including comorbidities, concurrent medications, and the overall clinical status of the individual. Assessing the risk-benefit profile, particularly in the presence of complex medical conditions, informs decision-making and ensures that therapeutic interventions align with the broader healthcare goals for individuals living with HIV. The long-term effects of exogenous EPO administration in HIV-associated anemia warrant continued investigation. Longitudinal studies are essential to elucidate the sustained impact on erythropoiesis, immune function, and overall disease progression. Regular follow-up assessments, including hematological parameters and viral dynamics, are crucial for monitoring treatment responses and adapting therapeutic strategies as needed. Therapeutic considerations for EPO in HIV-associated anemia should be integrated into a comprehensive care framework. Collaborative efforts involving hematologists, infectious disease specialists, and healthcare providers can optimize therapeutic decisions, ensuring a holistic approach that addresses both the hematological complications of HIV and the broader healthcare needs of the individual.[93]

Conclusion

The critical appraisal of erythropoietin (EPO) levels in the context of HIV-associated anemia illuminates a complex interplay between viral infection, hematopoiesis, and therapeutic considerations. This review has explored the regulatory mechanisms of EPO, its implications for hematopoiesis, and the evolving role it plays in the management of anemia in individuals living with HIV. Elevated or suppressed EPO levels serve as indicators of the severity of anemia and the adequacy of erythropoietic responses. Understanding the nuanced dynamics of EPO in HIV provides valuable insights into disease progression, immune status, and treatment outcomes. The potential use of EPO as a biomarker offers clinicians a tool to tailor therapeutic interventions, ensuring a personalized approach to anemia management.

References

1. Obeagu EI, Okwuanaso CB, Edoho SH, Obeagu GU. Under-nutrition among HIV-exposed Uninfected Children: A Review of African Perspective. Madonna University journal of Medicine and Health Sciences. 2022;2(3):120-127.
2. Obeagu EI, Alum EU, Obeagu GU. Factors associated with prevalence of HIV among youths: A review of Africa perspective. Madonna University journal of Medicine and Health Sciences. 2023;3(1):13-18. https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/93.
3. Obeagu EI. A Review of Challenges and Coping Strategies Faced by HIV/AIDS Discordant Couples. Madonna University journal of Medicine and Health Sciences. 2023

;3(1):7-12. https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/91.

4. Obeagu EI, Obeagu GU. An update on premalignant cervical lesions and cervical cancer screening services among HIV positive women. J Pub Health Nutri. 2023; 6 (2). 2023; 141:1-2. links/63e538ed64252375639dd0df/An-update-on-premalignant-cervical-lesions-and-cervical-cancer-screening-services-among-HIV-positive-women.pdf.
5. 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):10-19.
6. Omo-Emmanuel UK, Chinedum OK, Obeagu EI. Evaluation of laboratory logistics management information system in HIV/AIDS comprehensive health facilities in Bayelsa State, Nigeria. Int J Curr Res Med Sci. 2017;3(1): 21-38.DOI: 10.22192/ijcrms.2017.03.01.004
7. Obeagu EI, Obeagu GU, Musiimenta E, Bot YS, Hassan AO. Factors contributing to low utilization of HIV counseling and testing services. Int. J. Curr. Res. Med. Sci. 2023;9(2): 1-5.DOI: 10.22192/ijcrms.2023.09.02.001
8. Obeagu EI, Obeagu GU. An update on survival of people living with HIV in Nigeria. J Pub Health Nutri. 2022; 5 (6). 2022;129. links/645b4bfcf3512f1cc5885784/An-update-on-survival-of-people-living-with-HIV-in-Nigeria.pdf.
9. Offie DC, Obeagu EI, Akueshi C, Njab JE, Ekanem EE, Dike PN, Oguh DN. Facilitators and barriers to retention in HIV care among HIV infected MSM attending Community Health Center Yaba, Lagos Nigeria. Journal of Pharmaceutical Research International. 2021;33(52B):10-19.
10. 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):10-19.
11. Odo M, Ochei KC, Obeagu EI, Barinaadaa A, Eteng UE, Ikpeme M, Bassey JO, Paul AO. TB Infection Control in TB/HIV Settings in Cross River State, Nigeria: Policy Vs Practice. Journal of Pharmaceutical Research International. 2020;32(22):101-119.
12. Obeagu EI, Eze VU, Alaeboh EA, Ochei KC. Determination of haematocrit level and iron profile study among persons living with HIV in Umuahia, Abia State, Nigeria. J BioInnovation. 2016; 5:464-471. links/592bb4990f7e9b9979a975cf/DETERMINATION-OF-HAEMATOCRIT-LEVEL-AND-IRON-PROFILE-STUDY-AMONG-PERSONS-LIVING-WITH-HIV-IN-UMUAHIA-ABIA-STATE-NIGERIA.pdf.
13. Ifeanyi OE, Obeagu GU. The values of prothrombin time among HIV positive patients in FMC owerri. International Journal of Current Microbiology and Applied Sciences. 2015;4(4):911-916. https://www.academia.edu/download/38320140/Obeagu_Emmanuel_Ifeanyi_and_Obeagu__Getrude_Uzoma2.EMMA1.pdf.
14. Izuchukwu IF, Ozims SJ, Agu GC, Obeagu EI, Onu I, Amah H, Nwosu DC, Nwanjo HU, Edward A, Arunsi MO. Knowledge of preventive measures and management of HIV/AIDS victims among parents in Umuna Orlu community of Imo state Nigeria. Int. J. Adv. Res. Biol. Sci. 2016;3(10): 55-65.DOI; 10.22192/ijarbs.2016.03.10.009

15. Obeagu EI, Okoroiwu IL, Obeagu G. Molecular mechanism and systemic response of erythropoietin: A Review. Int. J. Adv. Res. Biol. Sci. 2015;2(7):58-62.
16. Obeagu EI, Okoroiwu II, Ezimah AC. Evaluation of serum erythropoietin levels in chronic kidney disease patients in Federal Medical centre, Umuahia, Nigeria. Int. J. Curr. Res. Biol. Med. 2016;1(4):15-21.
17. Obeagu EI. Erythropoeitin in Sickle Cell Anaemia: A Review. International Journal of Research Studies in Medical and Health Sciences. 2020;5(2):22-8.
18. Obeagu EI, Ezimah AC, Obeagu GU. Erythropoietin in the anaemias of pregnancy: a review. Int J Curr Res Chem Pharm Sci. 2016;3(3):10-18.
19. Obeagu EI, Ochei KC, Okeke EI, Anode AC. Assessment of the level of haemoglobin and erythropoietin in persons living with HIV in Umuahia. Int. J. Curr. Res. Med. Sci. 2016;2(4):29-33.
20. Obeagu EI, Obeagu GU, Nchuma BO, Amazue PO. A Review on erythropoietin receptor (EpoR). Int. J. Adv. Res. Biol. Sci. 2015;2(8):80-84.
21. Obeagu EI. Erythrocyte enumeration and serum erythropoietin in chronic kidney disease patients: A study in Federal Medical Centre, Umuahia, Nigeria. International Journal of Advanced Research in Biological Sciences. 2016;3(7):163-170.
22. Ifeanyi OE. A review on erythropoietin. Int J Adv Res Biol Sci. 2015;2(4):35-47.
23. Obeagu EI. Maximizing longevity: erythropoietin's impact on sickle cell anemia survival rates. Annals of Medicine and Surgery. 2024:10-97.
24. Chinedu K, Takim AE, Obeagu EI, Chinazor UD, Eloghosa O, Ojong OE, Odunze U. HIV and TB co-infection among patients who used Directly Observed Treatment Short-course centres in Yenagoa, Nigeria. IOSR J Pharm Biol Sci. 2017;12(4):70-75. links/5988ab6d0f7e9b6c8539f73d/HIV-and-TB-co-infection-among-patients-who-used-Directly-Observed-Treatment-Short-course-centres-in-Yenagoa-Nigeria.pdf
25. Oloro OH, Oke TO, Obeagu EI. Evaluation of Coagulation Profile Patients with Pulmonary Tuberculosis and Human Immunodeficiency Virus in Owo, Ondo State, Nigeria. Madonna University journal of Medicine and Health Sciences. 2022;2(3):110-119.
26. Nwosu DC, Obeagu EI, Nkwocha BC, Nwanna CA, Nwanjo HU, Amadike JN, Elendu HN, Ofoedeme CN, Ozims SJ, Nwankpa P. Change in Lipid Peroxidation Marker (MDA) and Non enzymatic Antioxidants (VIT C & E) in HIV Seropositive Children in an Urban Community of Abia State. Nigeria. J. Bio. Innov. 2016;5(1):24-30. links/5ae735e9a6fdcc5b33eb8d6a/CHANGE-IN-LIPID-PEROXIDATION-MARKER-MDAAND-NON-ENZYMATIC-ANTIOXIDANTS-VIT-C-E-IN-HIV-SEROPOSITIVE-CHILDREN-IN-AN-URBAN-COMMUNITY-OF-ABIA-STATE-NIGERIA.pdf.
27. Igwe CM, Obeagu IE, Ogbuabor OA. Clinical characteristics of people living with HIV/AIDS on ART in 2014 at tertiary health institutions in Enugu, Nigeria. J Pub Health Nutri. 2022; 5 (6). 2022;130. links/645a166f5762c95ac3817d32/Clinical-characteristics-of-people-living-with-HIV-AIDS-on-ART-in-2014-at-tertiary-health-institutions-in-Enugu.pdf.
28. Ifeanyi OE, Obeagu GU, Ijeoma FO, Chioma UI. The values of activated partial thromboplastin time (APTT) among HIV positive patients in FMC Owerri. Int J Curr Res

Aca Rev. 2015; 3:139-144. https://www.academia.edu/download/38320159/Obeagu_Emmanuel_Ifeanyi3__et_al.IJCRAR.pdf.

29. Obiomah CF, Obeagu EI, Ochei KC, Swem CA, Amachukwu BO. Hematological indices o HIV seropositive subjects in Nnamdi Azikiwe University teaching hospital (NAUTH), Nnewi. Ann Clin Lab Res. 2018;6(1):1-4. links/5aa2bb17a6fdccd544b7526e/Haematological-Indices-of-HIV-Seropositive-Subjects-at-Nnamdi-Azikiwe.pdf
30. Omo-Emmanuel UK, Ochei KC, Osuala EO, Obeagu EI, Onwuasoanya UF. Impact of prevention of mother to child transmission (PMTCT) of HIV on positivity rate in Kafanchan, Nigeria. Int. J. Curr. Res. Med. Sci. 2017;3(2): 28-34.DOI: 10.22192/ijcrms.2017.03.02.005
31. Aizaz M, Abbas FA, Abbas A, Tabassum S, Obeagu EI. Alarming rise in HIV cases in Pakistan: Challenges and future recommendations at hand. Health Science Reports. 2023;6(8):e1450.
32. Obeagu EI, Amekpor F, Scott GY. An update of human immunodeficiency virus infection: Bleeding disorders. J Pub Health Nutri. 2023; 6 (1). 2023;139. links/645b4a6c2edb8e5f094d9bd9/An-update-of-human-immunodeficiency-virus-infection-Bleeding.pdf.
33. Obeagu EI, Scott GY, Amekpor F, Ofodile AC, Edoho SH, Ahamefula C. Prevention of New Cases of Human Immunodeficiency Virus: Pragmatic Approaches of Saving Life in Developing Countries. Madonna University journal of Medicine and Health Sciences. 2022;2(3):128-134. https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/86.
34. Walter O, Anaebo QB, Obeagu EI, Okoroiwu IL. Evaluation of Activated Partial Thromboplastin Time and Prothrombin Time in HIV and TB Patients in Owerri Metropolis. Journal of Pharmaceutical Research International. 2022:29-34.
35. Odo M, Ochei KC, Obeagu EI, Barinaadaa A, Eteng EU, Ikpeme M, Bassey JO, Paul AO. Cascade variabilities in TB case finding among people living with HIV and the use of IPT: assessment in three levels of care in cross River State, Nigeria. Journal of Pharmaceutical Research International. 2020;32(24):9-18.
36. 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.
37. Obeagu EI, Obeagu GU. A Review of knowledge, attitudes and socio-demographic factors associated with non-adherence to antiretroviral therapy among people living with HIV/AIDS. Int. J. Adv. Res. Biol. Sci. 2023;10(9):135-142.DOI: 10.22192/ijarbs.2023.10.09.015 links/6516faa61e2386049de5e828/A-Review-of-knowledge-attitudes-and-socio-demographic-factors-associated-with-non-adherence-to-antiretroviral-therapy-among-people-living-with-HIV-AIDS.pdf

38. Obeagu EI, Onuoha EC. Tuberculosis among HIV Patients: A review of Prevalence and Associated Factors. Int. J. Adv. Res. Biol. Sci. 2023;10(9):128-134.DOI: 10.22192/ijarbs.2023.10.09.014 links/6516f938b0df2f20a2f8b0e0/Tuberculosis-among-HIV-Patients-A-review-of-Prevalence-and-Associated-Factors.pdf.
39. Ifeanyi OE, Uzoma OG. A review on erythropietin in pregnancy. J. Gynecol. Womens Health. 2018;8(3):1-4.
40. Obeagu EI, Okoroiwu IL, Obeagu GU. Relationship between Thrombopoietin and Interleukin 3: A Review. Int J Curr Res Chem Pharm. Sci. 2022;9(1):7-13.
41. Obeagu EI, Obeagu GU, Amilo GI. Haematological changes in patients of chronic kidney disease in Umuahia, Abia State, Nigeria. Curr Trends Biomed Eng Biosci. 2018; 11:34-7.
42. Obeagu EI, Okoroiwu IL, Azuonwu O. An update on hypoxic regulation of iron homeostasis and bone marrow environment. Int. J. Curr. Res. Med. Sci. 2018;4(10):42-8.
43. Obeagu EI. Blood Transfusion: A Powerful Process of Saving Anaemic Patients. EC Emergency Medicine and Critical Care. 2020;4(7):33-40.
44. Obeagu EI, Obeagu GU. Platelet Distribution Width (PDW) as a Prognostic Marker for Anemia Severity in HIV Patients: A Comprehensive Review. Journal home page: http://www. journalijiar. com.;12(01).
45. Obeagu EI, Obeagu GU, Obiezu J, Ezeonwumelu C, Ogunnaya FU, Ngwoke AO, Emeka-Obi OR, Ugwu OP. Hematologic Support in HIV Patients: Blood Transfusion Strategies and Immunological Considerations. APPLIED SCIENCES (NIJBAS). 2023;3(3).
46. Obeagu EI, Ibeh NC, Nwobodo HA, Ochei KC, Iwegbulam CP. Haematological indices of malaria patients coinfected with HIV in Umuahia. Int. J. Curr. Res. Med. Sci. 2017;3(5):100-104.DOI: 10.22192/ijcrms.2017.03.05.014 https://www.academia.edu/download/54317126/Haematological_indices_of_malaria_patients_coinfected_with_HIV.pdf
47. 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.
48. Viola N, Kimono E, Nuruh N, Obeagu EI. Factors Hindering Elimination of Mother to Child Transmission of HIV Service Uptake among HIV Positive Women at Comboni Hospital Kyamuhunga Bushenyi District. Asian Journal of Dental and Health Sciences. 2023;3(2):7-14. http://ajdhs.com/index.php/journal/article/view/39.
49. Okorie HM, Obeagu Emmanuel I, Okpoli Henry CH, Chukwu Stella N. Comparative study of enzyme linked immunosorbent assay (Elisa) and rapid test screening methods on HIV, Hbsag, Hcv and Syphilis among voluntary donors in. Owerri, Nigeria. J Clin Commun Med. 2020;2(3):180-183.DOI: **DOI:** 10.32474/JCCM.2020.02.000137 links/5f344530458515b7291bd95f/Comparative-Study-of-Enzyme-Linked-Immunosorbent-Assay-ElISA-and-Rapid-Test-Screening-Methods-on-HIV-HBsAg-HCV-and-Syphilis-among-Voluntary-Donors-in-Owerri-Nigeria.pdf.
50. Ezugwu UM, Onyenekwe CC, Ukibe NR, Ahaneku JE, Onah CE, Obeagu EI, Emeje PI, Awalu JC, Igbokwe GE. Use of ATP, GTP, ADP and AMP as an Index of Energy

Utilization and Storage in HIV Infected Individuals at NAUTH, Nigeria: A Longitudinal, Prospective, Case-Controlled Study. Journal of Pharmaceutical Research International. 2021;33(47A):78-84.

51. 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 Jul 29;6(1):203-211. http://research.sdpublishers.net/id/eprint/2819/.
52. Igwe MC, Obeagu EI, Ogbuabor AO, Eze GC, Ikpenwa JN, Eze-Steven PE. Socio-Demographic Variables of People Living with HIV/AIDS Initiated on ART in 2014 at Tertiary Health Institution in Enugu State. Asian Journal of Research in Infectious Diseases. 2022;10(4):1-7.
53. Vincent CC, Obeagu EI, Agu IS, Ukeagu NC, Onyekachi-Chigbu AC. Adherence to Antiretroviral Therapy among HIV/AIDS in Federal Medical Centre, Owerri. Journal of Pharmaceutical Research International. 2021;33(57A):360-368.
54. Igwe MC, Obeagu EI, Ogbuabor AO. ANALYSIS OF THE FACTORS AND PREDICTORS OF ADHERENCE TO HEALTHCARE OF PEOPLE LIVING WITH HIV/AIDS IN TERTIARY HEALTH INSTITUTIONS IN ENUGU STATE. Madonna University journal of Medicine and Health Sciences. 2022;2(3):42-57. https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/75.
55. Madekwe CC, Madekwe CC, Obeagu EI. Inequality of monitoring in Human Immunodeficiency Virus, Tuberculosis and Malaria: A Review. Madonna University journal of Medicine and Health Sciences. 2022;2(3):6-15. https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/69
56. Echendu GE, Vincent CC, Ibebuike J, Asodike M, Naze N, Chinedu EP, Ohale B, Obeagu EI. WEIGHTS OF INFANTS BORN TO HIV INFECTED MOTHERS: A PROSPECTIVE COHORT STUDY IN FEDERAL MEDICAL CENTRE, OWERRI, IMO STATE. European Journal of Pharmaceutical and Medical Research, 2023; 10(8): 564-568
57. Nwosu DC, Nwanjo HU, Okolie NJ, Ikeh K, Ajero CM, Dike J, Ojiegbe GC, Oze GO, Obeagu EI, Nnatunanya I, Azuonwu O. BIOCHEMICAL ALTERATIONS IN ADULT HIV PATIENTS ON ANTIRETRQVIRAL THERAPY. World Journal of Pharmacy and Pharmaceutical Sciences, 2015; 4(3): 153-160**.** links/5a4fd0500f7e9bbc10526b38/BIOCHEMICAL-ALTERATIONS-IN-ADULT-HIV-PATIENTS-ON-ANTIRETRQVIRAL-THERAPY.pdf.
58. Obeagu EI, Obeagu GU. Effect of CD4 Counts on Coagulation Parameters among HIV Positive Patients in Federal Medical Centre, Owerri, Nigeria. Int. J. Curr. Res. Biosci. Plant Biol. 2015;2(4):45-49.
59. Obeagu EI, Nwosu DC. Adverse drug reactions in HIV/AIDS patients on highly active antiretro viral therapy: a review of prevalence. Int. J. Curr. Res. Chem. Pharm. Sci. 2019;6(12):45-8.DOI: 10.22192/ijcrcps.2019.06.12.004 links/650aba1582f01628f0335795/Adverse-drug-reactions-in-HIV-AIDS-patients-on-highly-active-antiretro-viral-therapy-a-review-of-prevalence.pdf.

60. Obeagu EI, Scott GY, Amekpor F, Obeagu GU. Implications of CD4/CD8 ratios in Human Immunodeficiency Virus infections. Int. J. Curr. Res. Med. Sci. 2023;9(2):6-13.DOI: 10.22192/ijcrms.2023.09.02.002 links/645a4a462edb8e5f094ad37c/Implications-of-CD4-CD8-ratios-in-Human-Immunodeficiency-Virus-infections.pdf.
61. Obeagu EI, Ochei KC, Okeke EI, Anode AC. Assessment of the level of haemoglobin and erythropoietin in persons living with HIV in Umuahia. Int. J. Curr. Res. Med. Sci. 2016;2(4):29-33. links/5711c47508aeebe07c02496b/Assessment-of-the-level-of-haemoglobin-and-erythropoietin-in-persons-living-with-HIV-in-Umuahia.pdf.
62. Ifeanyi OE, Obeagu GU. The Values of CD4 Count, among HIV Positive Patients in FMC Owerri. Int. J. Curr. Microbiol. App. Sci. 2015;4(4):906-910. https://www.academia.edu/download/38320134/Obeagu_Emmanuel_Ifeanyi_and_Obeagu__Getrude_Uzoma.EMMA2.pdf.
63. Obeagu EI, Okeke EI, Anonde Andrew C. Evaluation of haemoglobin and iron profile study among persons living with HIV in Umuahia, Abia state, Nigeria. Int. J. Curr. Res. Biol. Med. 2016;1(2):1-5.
64. Alum EU, Ugwu OP, Obeagu EI, Okon MB. Curtailing HIV/AIDS Spread: Impact of Religious Leaders. Newport International Journal of Research in Medical Sciences (NIJRMS). 2023;3(2):28-31.
65. Obeagu EI, Obeagu GU, Paul-Chima UO. Stigma Associated With HIV. AIDS: A Review. Newport International Journal of Public Health and Pharmacy (NIJPP). 2023;3(2):64-67.
66. Alum EU, Obeagu EI, Ugwu OP, Aja PM, Okon MB. HIV Infection and Cardiovascular diseases: The obnoxious Duos. Newport International Journal of Research in Medical Sciences (NIJRMS). 2023;3(2):95-99.
67. Ibebuike JE, Nwokike GI, Nwosu DC, Obeagu EI. A Retrospective Study on Human Immune Deficiency Virus among Pregnant Women Attending Antenatal Clinic in Imo State University Teaching Hospital. *International Journal of Medical Science and Dental Research,* 2018; 1 (2):08-14. https://www.ijmsdr.org/published%20paper/li1i2/A%20Retrospective%20Study%20on%20Human%20Immune%20Deficiency%20Virus%20among%20Pregnant%20Women%20Attending%20Antenatal%20Clinic%20in%20Imo%20State%20University%20Teaching%20Hospital.pdf.
68. Obeagu EI, Obarezi TN, Omeh YN, Okoro NK, Eze OB. Assessment of some haematological and biochemical parametrs in HIV patients before receiving treatment in Aba, Abia State, Nigeria. Res J Pharma Biol Chem Sci. 2014; 5:825-830.
69. Obeagu EI, Obarezi TN, Ogbuabor BN, Anaebo QB, Eze GC. Pattern of total white blood cell and differential count values in HIV positive patients receiving treatment in Federal Teaching Hospital Abakaliki, Ebonyi State, Nigeria. International Journal of Life Science, Biotechnology and Pharama Research. 2014; 391:186-189.
70. Obeagu EI. A Review of Challenges and Coping Strategies Faced by HIV/AIDS Discordant Couples. Madonna University journal of Medicine and Health Sciences. 2023; 3 (1): 7-12.
71. Oloro OH, Obeagu EI. A Systematic Review on Some Coagulation Profile in HIV Infection. International Journal of Innovative and Applied Research. 2022;10(5):1-11.

Citation: Obeagu EI, Obeagu GU. **A Critical Appraisal of Erythropoietin Levels in HIV: Clinical Relevance**. Elite Journal of Laboratory Medicine, 2024; 2(1): 1-13

72. Nwosu DC, Obeagu EI, Nkwuocha BC, Nwanna CA, Nwanjo HU, Amadike JN, Ezemma MC, Okpomeshine EA, Ozims SJ, Agu GC. Alterations in superoxide dismutiase, vitamins C and E in HIV infected children in Umuahia, Abia state. International Journal of Advanced Research in Biological Sciences. 2015;2(11):268-271.
73. 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):56-59.
74. Ifeanyi OE, Uzoma OG, Stella EI, Chinedum OK, Abum SC. Vitamin D and insulin resistance in HIV sero positive individuals in Umudike. Int. J. Curr. Res. Med. Sci. 2018;4(2):104-108.
75. Ifeanyi OE, Leticia OI, Nwosu D, Chinedum OK. A Review on blood borne viral infections: universal precautions. Int. J. Adv. Res. Biol. Sci. 2018;5(6):60-66.
76. Nwovu AI, Ifeanyi OE, Uzoma OG, Nwebonyi NS. Occurrence of Some Blood Borne Viral Infection and Adherence to Universal Precautions among Laboratory Staff in Federal Teaching Hospital Abakaliki Ebonyi State. Arch Blood Transfus Disord. 2018;1(2).
77. Chinedu K, Takim AE, Obeagu EI, Chinazor UD, Eloghosa O, Ojong OE, Odunze U. HIV and TB co-infection among patients who used Directly Observed Treatment Short-course centres in Yenagoa, Nigeria. IOSR J Pharm Biol Sci. 2017;12(4):70-75.
78. Offie DC, Obeagu EI, Akueshi C, Njab JE, Ekanem EE, Dike PN, Oguh DN. Facilitators and barriers to retention in HIV care among HIV infected MSM attending Community Health Center Yaba, Lagos Nigeria. Journal of Pharmaceutical Research International. 2021;33(52B):10-19.
79. Obeagu EI, Obeagu GU, Ede MO, Odo EO, Buhari HA. Translation of HIV/AIDS knowledge into behavior change among secondary school adolescents in Uganda: A review. Medicine (Baltimore). 2023;102(49): e36599. doi: 10.1097/MD.0000000000036599. PMID: 38065920; PMCID: PMC10713174.
80. Anyiam AF, Arinze-Anyiam OC, Irondi EA, Obeagu EI. Distribution of ABO and rhesus blood grouping with HIV infection among blood donors in Ekiti State Nigeria. Medicine (Baltimore). 2023;102(47): e36342. doi: 10.1097/MD.0000000000036342. PMID: 38013335; PMCID: PMC10681551.
81. Echefu SN, Udosen JE, Akwiwu EC, Akpotuzor JO, Obeagu EI. Effect of Dolutegravir regimen against other regimens on some hematological parameters, CD4 count and viral load of people living with HIV infection in South Eastern Nigeria. Medicine (Baltimore). 2023;102(47): e35910. doi: 10.1097/MD.0000000000035910. PMID: 38013350; PMCID: PMC10681510.
82. Opeyemi AA, Obeagu EI. Regulations of malaria in children with human immunodeficiency virus infection: A review. Medicine (Baltimore). 2023;102(46): e36166. doi: 10.1097/MD.0000000000036166. PMID: 37986340; PMCID: PMC10659731.
83. Alum EU, Obeagu EI, Ugwu OPC, Samson AO, Adepoju AO, Amusa MO. Inclusion of nutritional counseling and mental health services in HIV/AIDS management: A paradigm shift. Medicine (Baltimore). 2023;102(41): e35673. doi: 10.1097/MD.0000000000035673. PMID: 37832059; PMCID: PMC10578718.

Citation: Obeagu EI, Obeagu GU. **A Critical Appraisal of Erythropoietin Levels in HIV: Clinical Relevance**. Elite Journal of Laboratory Medicine, 2024; 2(1): 1-13

84. Aizaz M, Abbas FA, Abbas A, Tabassum S, Obeagu EI. Alarming rise in HIV cases in Pakistan: Challenges and future recommendations at hand. Health Sci Rep. 2023;6(8): e1450. doi: 10.1002/hsr2.1450. PMID: 37520460; PMCID: PMC10375546.
85. Obeagu EI, Obeagu GU, Obiezu J, Ezeonwumelu C, Ogunnaya FU, Ngwoke AO, Emeka-Obi OR, Ugwu OP. Hematologic Support in HIV Patients: Blood Transfusion Strategies and Immunological Considerations. APPLIED SCIENCES (NIJBAS). 2023;3(3).
86. Obeagu EI, Ubosi NI, Uzoma G. Storms and Struggles: Managing HIV Amid Natural Disasters. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(11):14-25.
87. Obeagu EI, Obeagu GU. Human Immunodeficiency Virus and tuberculosis infection: A review of prevalence of associated factors. Int. J. Adv. Multidiscip. Res. 2023;10(10):56-62.
88. 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.
89. Alum EU, Ugwu OP, Obeagu EI, Aja PM, Okon MB, Uti DE. Reducing HIV Infection Rate in Women: A Catalyst to reducing HIV Infection pervasiveness in Africa. International Journal of Innovative and Applied Research. 2023;11(10):01-6.
90. Henry DH, Volberding PA, Leitz G. Epoetin alfa for treatment of anemia in HIV-infected patients: past, present, and future. JAIDS Journal of Acquired Immune Deficiency Syndromes. 2004;37(2):1221-1227.
91. Vishnu P, Aboulafia DM. Haematological manifestations of human immune deficiency virus infection. British journal of haematology. 2015;171(5):695-709.
92. Obeagu EI, Obeagu GU, Ukibe NR, Oyebadejo SA. Anemia, iron, and HIV: decoding the interconnected pathways: A review. Medicine. 2024;103(2):e36937.
93. Daniel Elbirt M, Mahlab-Guri K, Bazalel-Rosenberg S, Attali M, Asher I. HIV-associated neurocognitive disorders (HAND). Isr. Med. Assoc. J. 2015; 17:54.
94. Mesgarpour B, Heidinger BH, Roth D, Schmitz S, Walsh CD, Herkner H. Harms of off-label erythropoiesis-stimulating agents for critically ill people. Cochrane Database of Systematic Reviews. 2017(8).