Elite Journal of Nursing and Health Sciences. Volume 1 issue 1(2023), Pp. 13-23 https://epjournals.com/journals/EJNHS

Unraveling Diagnostic Challenges of Aplastic Anemia in the Context of HIV: A Review

*Emmanuel Ifeanyi Obeagu[1]

[1]Department of Medical Laboratory 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

Aplastic anemia (AA) and Human Immunodeficiency Virus (HIV) infection represent distinct hematologic disorders that can coexist, posing diagnostic and management challenges. This review delves into the complex interplay between AA and HIV, specifically focusing on the diagnostic hurdles encountered in identifying AA within the context of HIV infection. We explore the overlapping clinical presentations, diagnostic dilemmas, and therapeutic considerations crucial for optimal patient care. Emphasizing the importance of a comprehensive diagnostic approach, including bone marrow examination, flow cytometry, and molecular testing, we highlight the need for heightened clinical suspicion and multidisciplinary collaboration in managing AA in HIV-positive individuals. Research is warranted to refine diagnostic strategies and elucidate optimal therapeutic approaches, particularly regarding hematopoietic stem cell transplantation, in this intricate patient population.

Keywords: *Aplastic anemia, HIV, bone marrow failure, diagnosis, challenges, management, hematopoietic stem cell transplantation*

Introduction

Aplastic anemia (AA) stands as a rare but severe hematologic disorder characterized by bone marrow failure, culminating in pancytopenia. In contrast, Human Immunodeficiency Virus (HIV) infection remains a global public health concern, marked by immune dysfunction and a spectrum of hematologic abnormalities. When these two entities coexist, clinicians face formidable diagnostic and management challenges due to overlapping clinical features and shared pathogenic mechanisms. The intersection of AA and HIV presents a unique conundrum, demanding a nuanced understanding of their individual pathophysiologies and their combined effects on hematopoiesis. The clinical presentation of AA in individuals with HIV can often mimic or be masked by the

manifestations of HIV-related cytopenias, posing a considerable diagnostic dilemma. Pancytopenia, a cardinal feature of AA, is also frequently observed in advanced stages of HIV infection due to bone marrow suppression by the virus itself or as a consequence of myelosuppressive therapies. Consequently, differentiating between AA and HIV-related cytopenias necessitates a meticulous and comprehensive diagnostic approach, aiming to elucidate the underlying etiology and guide appropriate therapeutic interventions.[1-18]

Bone marrow examination remains the cornerstone for diagnosing AA and evaluating marrow cellularity, architecture, and the presence of dysplastic changes. However, interpreting bone marrow findings in the context of HIV infection requires caution, as HIV-related marrow alterations, such as dysplasia and viral infiltration, can confound the diagnostic interpretation. To complement traditional diagnostic modalities, flow cytometry and molecular testing play increasingly pivotal roles in discerning the underlying pathology, particularly in cases where bone marrow examination yields inconclusive results or fails to definitively differentiate between AA and HIV-related hematologic abnormalities. The management of AA in the setting of HIV demands a multidisciplinary approach, navigating the delicate balance between immunosuppressive therapy for AA and antiretroviral therapy (ART) for HIV. While hematopoietic stem cell transplantation (HSCT) remains the sole curative option for refractory AA, its feasibility, safety, and outcomes in HIV-positive patients remain areas of ongoing investigation and debate. The complexities surrounding the diagnosis and management of AA in individuals living with HIV underscore the pressing need for further research to optimize diagnostic strategies, therapeutic approaches, and long-term outcomes in this intricate patient population.[19-29]

Clinical Presentation and Diagnostic Challenges

The clinical presentation of aplastic anemia (AA) within the context of HIV infection poses significant challenges due to overlapping manifestations and the potential for misdiagnosis. Both conditions can lead to pancytopenia, presenting as anemia, thrombocytopenia, and leukopenia, which are hallmarks of bone marrow failure. However, discerning whether these cytopenias arise primarily from AA, HIV-related myelosuppression, or a combination of both requires a thorough understanding of the underlying pathophysiology and a nuanced diagnostic approach. One of the primary diagnostic challenges lies in distinguishing between AA and HIV-related cytopenias based solely on clinical presentation. In HIV-infected individuals, cytopenias can result from various factors, including direct viral effects on hematopoietic progenitor cells, opportunistic infections, medication side effects, or autoimmune phenomena. Conversely, AA is characterized by immune-mediated destruction of hematopoietic stem cells, leading to bone marrow aplasia. Thus, clinical history, physical examination, and laboratory findings alone may not suffice to differentiate between these etiologies definitively.[30-41]

HIV infection itself can cause dysplastic changes, marrow hypoplasia, or hyperplasia, complicating the interpretation of bone marrow aspirate and biopsy specimens. To complement bone marrow examination, ancillary tests such as flow cytometry and molecular testing play increasingly important roles in elucidating the underlying pathology. Flow cytometry enables the

detection of aberrant immune cell populations and clonal hematopoiesis, which may suggest an underlying AA in individuals with HIV. Molecular testing, including assays for telomere length and mutations in genes associated with AA, provides valuable diagnostic and prognostic information, aiding in the differentiation of AA from HIV-related cytopenias. Despite advances in diagnostic modalities, distinguishing AA from HIV-related cytopenias remains challenging, often requiring a multidisciplinary approach and consideration of multiple factors, including clinical history, laboratory findings, and ancillary tests. Clinicians must maintain a high index of suspicion for AA in HIV-infected individuals presenting with cytopenias, as timely diagnosis and intervention are critical for optimizing patient outcomes and guiding appropriate therapeutic strategies. Further research is warranted to refine diagnostic algorithms and improve our understanding of the complex interplay between AA and HIV infection.[42-53]

Bone Marrow Examination

Bone marrow examination stands as a pivotal component in the diagnostic workup of individuals with suspected aplastic anemia (AA) within the context of HIV infection. This invasive procedure involves the aspiration and biopsy of bone marrow tissue from the posterior iliac crest or, less commonly, the sternum. The examination of bone marrow morphology, cellularity, and the presence of dysplastic changes provides valuable insights into the underlying pathology and aids in distinguishing AA from other causes of pancytopenia in HIV-positive patients. In individuals with AA, bone marrow examination typically reveals hypocellular or aplastic marrow, characterized by a reduction in the number of hematopoietic precursor cells and an increase in fat cells. Additionally, the presence of characteristic morphological abnormalities, such as increased marrow space, diminished or absent trilineage hematopoiesis, and the absence of malignant cells, supports the diagnosis of AA. However, interpreting bone marrow findings in the setting of HIV infection requires careful consideration of potential confounding factors.[54-65]

HIV infection can exert direct and indirect effects on the bone marrow, leading to a spectrum of morphological changes that may overlap with those observed in AA. Marrow hypoplasia, dysplasia, and reactive changes, including increased plasma cells and histiocytes, can occur in individuals with HIV, irrespective of the presence of AA. Moreover, opportunistic infections, such as Mycobacterium avium complex and cytomegalovirus, and medication-related toxicity can further complicate the interpretation of bone marrow specimens. The differential diagnosis of bone marrow findings in HIV-infected individuals presenting with pancytopenia encompasses a broad range of conditions, including AA, HIV-related myelosuppression, opportunistic infections, and malignancies. Therefore, integrating clinical history, laboratory data, and ancillary tests is crucial for accurate diagnosis and appropriate management decisions. In cases where bone marrow examination alone does not provide a definitive diagnosis, additional diagnostic modalities, such as flow cytometry and molecular testing, may be warranted to further characterize the underlying pathology. Despite its limitations and interpretive challenges, bone marrow examination remains indispensable in the diagnostic evaluation of AA in HIV-positive patients. Clinicians must exercise caution and awareness of potential confounders when interpreting bone marrow findings in this complex patient population, striving to achieve an accurate diagnosis and guide optimal therapeutic strategies to improve patient outcomes. Continued research efforts are essential to

refine diagnostic algorithms and enhance our understanding of the interplay between AA and HIV infection at the bone marrow level.[66-72]

Flow Cytometry and Molecular Testing

In the diagnostic landscape of aplastic anemia (AA) within the context of HIV infection, flow cytometry and molecular testing emerge as indispensable adjuncts to traditional diagnostic modalities, providing valuable insights into the underlying pathology and aiding in the differentiation of AA from HIV-related cytopenias.[73] Flow cytometry enables the quantitative and qualitative assessment of cellular populations within the bone marrow, peripheral blood, or other tissues. In the evaluation of AA, flow cytometry serves as a powerful tool for detecting aberrant immune cell populations and clonal hematopoiesis, which may suggest an underlying AA in HIV-infected individuals. Specifically, flow cytometric analysis can identify deviations in the expression patterns of cell surface markers, such as CD34, CD45, and CD59, indicative of dysregulated hematopoiesis and immune cell dysfunction characteristic of AA.[74] Furthermore, flow cytometry facilitates the detection of immune-mediated destruction of hematopoietic stem cells through the assessment of complement-mediated lysis and the presence of paroxysmal nocturnal hemoglobinuria (PNH) clones. The identification of PNH clones, characterized by deficiency or absence of glycosylphosphatidylinositol (GPI)-anchored proteins, such as CD55 and CD59, provides valuable diagnostic and prognostic information, aiding in the differentiation of AA from other causes of pancytopenia in HIV-positive patients.

Molecular testing encompasses a diverse array of techniques aimed at elucidating the genetic and molecular mechanisms underlying AA and HIV-related hematologic abnormalities.[75] Assays for telomere length and mutations in genes associated with AA, such as telomerase reverse transcriptase (TERT), telomerase RNA component (TERC), and genes involved in the Fanconi anemia pathway, offer insights into the pathogenesis and prognosis of AA in HIV-infected individuals. Moreover, molecular testing can help identify acquired somatic mutations, such as mutations in the PIG-A gene, associated with the development of PNH clones in AA. The integration of flow cytometry and molecular testing into the diagnostic workup of AA in HIV-positive patients enhances the sensitivity and specificity of diagnostic algorithms, enabling more accurate and timely diagnosis. However, challenges persist, including accessibility to specialized testing facilities, standardization of assays, and interpretation of results in the context of HIV-related hematologic abnormalities. Despite these challenges, flow cytometry and molecular testing represent valuable adjuncts to conventional diagnostic approaches, offering insights into the underlying pathophysiology of AA and guiding personalized therapeutic strategies in HIV-infected individuals. Continued research efforts aimed at refining and standardizing these techniques are essential to optimize diagnostic accuracy and improve patient outcomes in this complex patient population.

Conclusion

The diagnosis and management of AA in HIV-positive individuals pose significant challenges due to overlapping clinical features and pathogenic mechanisms. Clinicians must maintain a high index

of suspicion for AA in HIV-infected patients presenting with cytopenias, employing a comprehensive diagnostic approach to differentiate between AA and HIV-related hematologic abnormalities.

References

1. Sankar V, Villa A. Hematologic diseases. Burket's Oral Medicine. 2021:627-664.
2. Weinzierl EP, Arber DA. The differential diagnosis and bone marrow evaluation of new-onset pancytopenia. American journal of clinical pathology. 2013;139(1):9-29.
3. Smith JN, Kanwar VS, MacNamara KC. Hematopoietic stem cell regulation by type I and II interferons in the pathogenesis of acquired aplastic anemia. Frontiers in Immunology. 2016; 7:217479.
4. Storb RF, Lucarelli G, McSweeney PA, Childs RW. Hematopoietic cell transplantation for benign hematological disorders and solid tumors. ASH Education Program Book. 2003;2003(1):372-397.
5. Volberding PA, Baker KR, Levine AM. Human immunodeficiency virus hematology. ASH Education Program Book. ;2003(1):294-313.
6. Blood GA. Human immunodeficiency virus (HIV). Transfusion Medicine and Hemotherapy. 2016;43(3):203.
7. Parekh BS, Ou CY, Fonjungo PN, Kalou MB, Rottinghaus E, Puren A, Alexander H, Hurlston Cox M, Nkengasong JN. Diagnosis of human immunodeficiency virus infection. Clinical microbiology reviews. 2018;32(1):10-128.
8. Opie J. Haematological complications of HIV infection: forum-review. South African Medical Journal. 2012;102(6):465-468.
9. 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.
10. 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.
11. 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.
12. 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.
13. 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

14. 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.
15. 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.
16. 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.
17. 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.
18. 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.
19. Gandhi S, Abuarqoub H, Kordasti S, Jiang J, Kulasekararaj A, Mufti G, Marsh JC. Pathology of bone marrow failure syndromes. Diagnostic Histopathology. 2015;21(5):174-180.
20. 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.
21. 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
22. 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
23. 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.
24. 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.

25. 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.
26. 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
27. 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
28. 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.
29. 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.
30. Bonadies N, Rovó A, Porret N, Bacher U. When should we think of myelodysplasia or bone marrow failure in a thrombocytopenic patient? A practical approach to diagnosis. Journal of clinical medicine. 2021;10(5):1026.
31. Groarke EM, Young NS, Calvo KR. Distinguishing constitutional from acquired bone marrow failure in the hematology clinic. Best Practice & Research Clinical Haematology. 2021;34(2):101275.
32. 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.
33. 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.
34. 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.
35. 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.

36. 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
37. 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.
38. 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
39. 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.
40. 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.
41. 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.
42. 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/.
43. 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.

44. 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
45. 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
46. 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.
47. 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.
48. 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.
49. 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.
50. 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.
51. 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.
52. 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.
53. 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%2

0Attending%20Antenatal%20Clinic%20in%20Imo%20State%20University%20Teaching%20Hospital.pdf.

54. Wilson CS, Brynes RK. Evaluation of anemia, leukopenia, and thrombocytopenia. Hematopathology E-Book. 2010:154.
55. DeZern AE, Churpek JE. Approach to the diagnosis of aplastic anemia. Blood Advances. 2021;5(12):2660-2671.
56. 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.
57. 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.
58. 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.
59. 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.
60. 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.
61. 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.
62. 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.
63. 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).
64. 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.
65. 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.
66. 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.
67. 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.
68. 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.
69. 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.
70. Obeagu EI, Obeagu GU, Obiezu J, Ezeonwumelu C, Ogunnaya FU, Ngwoke AO, Emeka-Obi OR,
71. 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.
72. 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.
73. Döhner H, Wei AH, Appelbaum FR, Craddock C, DiNardo CD, Dombret H, Ebert BL, Fenaux P, Godley LA, Hasserjian RP, Larson RA. Diagnosis and management of AML in adults: 2022 recommendations from an international expert panel on behalf of the ELN. Blood, The Journal of the American Society of Hematology. 2022;140(12):1345-1377.
74. Acevedo A, Alférez S, Merino A, Puigví L, Rodellar J. Automatic recognition system of nucleated peripheral blood cell images. Int. J. Lab. Hematol. 2016; 38:1-.
75. Yusuf AA, Musa BM, Galadanci NA, Babashani M, Mohammed AZ, Ingles DJ, Fogo AB, Wester CW, Aliyu MH. HIV-associated nephropathy: Protocol and rationale for an exploratory genotype-phenotype study in a sub-Saharan African population. Plos one. 2021;16(4):e0249567.