Immunological Challenges in Infants Living with HIV: A Review

Article *in* Virology & Immunology Journal · February 2024

DOI: 10.23880/vij-16000340

3 authors, including:

Getrude Uzoma Obeagu
Kampala International University (KIU)
321 PUBLICATIONS **2,310** CITATIONS

SEE PROFILE

Emmanuel Ifeanyi Obeagu
Kampala International University (KIU)
1,329 PUBLICATIONS **8,468** CITATIONS

SEE PROFILE

MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Virology & Immunology Journal
ISSN: 2577-4379

Immunological Challenges in Infants Living with HIV: A Review

Obeagu EI[1]* and Obeagu GU[2]

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

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

Mini Review

Volume 8 Issue 1

Received Date: February 08, 2024

Published Date: February 21, 2024

DOI: 10.23880/vij-16000340

***Corresponding author:** Emmanuel Ifeanyi Obeagu, Department of Medical Laboratory Science, Kampala International University, Uganda, Email: emmanuelobeagu@yahoo.com

Abstract

This paper explores the intricate immunological challenges encountered by infants living with Human Immunodeficiency Virus (HIV). The vulnerability of the developing immune system in early life, coupled with the unique characteristics of HIV, presents a complex scenario that impacts the health and well-being of these infants. Key areas of focus include the disruption of immune system development, viral persistence mechanisms, consequences of chronic immune activation, and the increased susceptibility to opportunistic infections. The paper also discusses current therapeutic interventions, emphasizing the significance of early antiretroviral therapy (ART) initiation and emerging strategies aimed at improving immunological outcomes. Insights into the maternal-fetal interface and preventive measures are explored, providing a holistic perspective on addressing the challenges faced by infants born with HIV. This comprehensive analysis aims to contribute to a deeper understanding of the immunological landscape in this vulnerable population and guide future research and interventions for enhanced patient care.

Keywords: Pediatrics; HIV; Infant immunology; Vertical transmission; Antiretroviral therapy; Viral persistence

Abbreviations: HIV: Human Immunodeficiency Virus; ART: Antiretroviral Therapy; PMTCT: Preventing Mother-To-Child Transmission

Introduction

Human Immunodeficiency Virus (HIV) infection continues to pose a significant global health challenge, particularly among infants born to HIV-positive mothers. Vertical transmission of the virus during pregnancy, childbirth, or breastfeeding results in infants acquiring HIV early in life, subjecting them to unique immunological challenges. The delicate balance between the developing immune system and the complexities of HIV presents a multifaceted landscape that requires a thorough examination [1-11]. The transmission of HIV from mother to child, known as vertical transmission, remains a substantial public health concern, particularly in regions with high prevalence rates. Despite substantial progress in preventing mother-to-child transmission (PMTCT) through antiretroviral therapy (ART) and other interventions, infants born with HIV face intricate immunological hurdles that necessitate a comprehensive understanding [12-21].

This review aims to provide a comprehensive exploration of the immunological challenges encountered by infants living with HIV. Focusing on key aspects such as immune system development, viral persistence, chronic immune activation, and therapeutic interventions, the objective is to shed light on the intricate dynamics shaping the immunological landscape of these vulnerable individuals. The developing immune system of infants undergoes rapid maturation, establishing

the foundation for a lifetime of immune defense. However, HIV disrupts this process, compromising the ability of the immune system to mount effective responses. Unraveling the immunological intricacies in infants living with HIV is crucial for developing targeted interventions to enhance their immune function, reduce susceptibility to infections, and improve overall health outcomes [22-31].

Immune System Development in Infants

The immune system of infants undergoes a complex and dynamic process of development during the early stages of life, laying the foundation for a robust defense against pathogens. However, infants born with HIV face unique challenges that disrupt the normal trajectory of immune system maturation [32-36]. The thymus plays a pivotal role in the development of T-cells, a crucial component of the adaptive immune system. In infants with HIV, thymic function is significantly impaired, leading to reduced production and maturation of T-cells. This impairment contributes to a diminished T-cell repertoire, compromising the ability to mount effective immune responses against a wide range of pathogens [37]. A diverse T-cell repertoire is essential for recognizing and responding to a myriad of pathogens. However, HIV infection in infants results in a skewed and narrowed T-cell repertoire. The virus's ability to infect and deplete CD4+ T-cells, particularly in the thymus, contributes to a restricted T-cell diversity. This limitation hampers the immune system's capacity to adapt to evolving infectious threats, making infants more susceptible to infections [38-47].

B-cells are responsible for antibody production and contribute to long-term immune memory. In infants living with HIV, the maturation of B-cells is compromised, affecting the production of specific antibodies. This compromise not only impairs the ability to neutralize pathogens but also diminishes the effectiveness of vaccination strategies in these infants [48-52]. The compromised immune system development in infants with HIV has far-reaching implications for their ability to mount effective immune responses. The weakened adaptive immune responses, coupled with deficiencies in innate immunity, create a scenario where the infant is more susceptible to a broad spectrum of infections. This heightened vulnerability underscores the critical need for early and targeted interventions to support immune development in this population [53-62]. Initiating antiretroviral therapy (ART) in the early stages of life has shown promise in mitigating the impact of HIV on immune system development. Successful suppression of viral replication through ART allows for partial restoration of thymic function and T-cell diversity. Consequently, early ART initiation not only improves the immediate health of the infant but also has implications for long-term immune resilience [63-71].

Viral Persistence

One of the defining features of Human Immunodeficiency Virus (HIV) infection is its ability to establish persistent and latent reservoirs within the host, creating significant challenges for immune control and eradication. In infants living with HIV, the dynamics of viral persistence present a unique set of obstacles that influence disease progression and therapeutic outcomes [72-75]. HIV can establish latent reservoirs early in infection, allowing the virus to evade the immune system and antiretroviral therapy (ART) [76]. In infants, these latent reservoirs are established in various cellular compartments, including resting CD4+ T-cells, macrophages, and potentially in anatomical sanctuaries such as the central nervous system. The establishment of these reservoirs poses a long-term barrier to achieving viral eradication.

Vertical transmission from an infected mother to her child represents a critical point for reservoir seeding. The transmission of virus during pregnancy, childbirth, or breastfeeding introduces HIV to the developing immune system of the infant, leading to the early establishment of viral reservoirs [77]. This early seeding contributes to the challenge of achieving complete viral suppression, even with early initiation of antiretroviral therapy. HIV has evolved various strategies to evade immune surveillance, contributing to the establishment and maintenance of viral reservoirs. The virus exhibits a high mutation rate, allowing it to escape recognition by the immune system. Additionally, the ability of HIV to infect and persist in long-lived cells contributes to the resilience of viral reservoirs, limiting the effectiveness of immune responses. The persistence of HIV within cellular reservoirs has profound implications for immune responses in infants [78]. The constant antigenic stimulation from the persistent viral reservoirs contributes to chronic immune activation and exhaustion. The compromised immune landscape hampers the ability of the immune system to mount effective responses against both HIV and opportunistic infections, contributing to the overall immunodeficiency observed in infants living with the virus.

Immune Activation and Inflammation

Human Immunodeficiency Virus (HIV) infection in infants not only disrupts the normal maturation of the immune system but also triggers persistent immune activation and chronic inflammation. This sustained inflammatory state plays a central role in the progression of the disease, impacting both the immediate and long-term health outcomes for infants living with HIV. HIV infection induces chronic immune activation through multiple mechanisms. The virus itself, as well as viral products, can stimulate immune cells, leading to the continuous production of inflammatory

cytokines and activation of immune pathways. Persistent antigenic stimulation, even in the presence of antiretroviral therapy (ART), contributes to a state of heightened immune activation in infants [79]. Chronic immune activation disrupts T-cell homeostasis in infants living with HIV. The constant stimulation of T-cells leads to their exhaustion, dysfunction, and increased susceptibility to apoptosis. This impairment in T-cell function not only compromises the ability to control HIV replication but also increases vulnerability to opportunistic infections. Prolonged exposure to HIV antigens results in the exhaustion of T-cells, characterized by functional impairment and reduced responsiveness [80]. In infants, immune exhaustion may manifest early in life, limiting the development of effective immune memory and hindering the adaptive immune responses necessary for long-term protection against pathogens.

Chronic immune activation and inflammation contribute significantly to the overall immunodeficiency observed in infants with HIV. The exhaustion of immune cells, particularly CD4+ T-cells, disrupts the balance between effector and regulatory components of the immune system, further compromising the ability to mount adequate immune responses against both HIV and opportunistic infections. The state of chronic immune activation creates a milieu where infants living with HIV are more susceptible to opportunistic infections [81]. The weakened immune responses, coupled with compromised T-cell function, increase the risk of severe and recurrent infections, contributing to the morbidity and mortality associated with pediatric HIV infection. Addressing chronic immune activation and inflammation has become a key focus in the management of HIV in infants. Initiating early and effective antiretroviral therapy (ART) plays a central role in controlling viral replication and reducing immune activation. Additionally, interventions aimed at modulating immune responses, such as anti-inflammatory medications or immune-modulatory agents, may hold promise in mitigating the adverse effects of chronic inflammation.

Immunodeficiency and Increased Susceptibility

Infants born with Human Immunodeficiency Virus (HIV) face profound immunodeficiency, resulting from the virus's ability to target and compromise key components of the immune system. This compromised immune landscape significantly increases their susceptibility to a spectrum of opportunistic infections, shaping the clinical course of HIV in early life. HIV primarily targets CD4+ T-cells, crucial orchestrators of the immune response. In infants living with HIV, the virus's ability to infect and deplete these immune cells leads to a rapid decline in CD4+ T-cell counts [82]. This depletion weakens the adaptive immune responses, impairing the ability to mount effective defenses against pathogens. The impact of HIV on immune cell subsets extends beyond CD4+ T-cells. Disruption of the overall immune system includes impaired cytotoxic T-cell function, compromised macrophage activity, and altered B-cell responses. The consequence is a broad immunodeficiency, affecting both cellular and humoral arms of the immune system, leaving infants susceptible to a wide range of infectious agents [83].

The compromised immune system in infants living with HIV renders them highly susceptible to opportunistic infections [84]. Common pathogens, which are typically controlled by a healthy immune system, can cause severe and recurrent infections in HIV-infected infants. Pneumocystis jirovecii, Mycobacterium avium complex, and cytomegalovirus are examples of opportunistic infections that pose a heightened threat in this population. Immunodeficiency contributes significantly to the increased morbidity and mortality observed in infants with HIV. The inability to mount effective immune responses against opportunistic infections leads to a higher frequency and severity of illnesses. Respiratory, gastrointestinal, and neurological complications become more pronounced, impacting the overall well-being and survival of HIV-infected infants.

Maternal-Fetal Interface and Prevention Strategies

The management of infants born with Human Immunodeficiency Virus (HIV) requires a multifaceted approach aimed at controlling viral replication, mitigating immunodeficiency, and improving overall health outcomes. This section explores current therapeutic interventions, with a focus on antiretroviral therapy (ART), immune-based strategies, and emerging developments in the pediatric HIV treatment landscape. Initiating antiretroviral therapy (ART) at the earliest possible stage is a cornerstone of managing HIV in infants [85]. Early treatment not only suppresses viral replication but also helps preserve immune function, reducing the risk of opportunistic infections. Pediatric-specific formulations of antiretroviral drugs have been developed to facilitate administration in infants, addressing the unique challenges associated with dosing and palatability. The primary goal of ART in infants is to achieve and maintain viral suppression. Successful viral suppression not only improves immediate health outcomes but also contributes to long-term immune reconstitution. Monitoring viral load is essential for assessing treatment efficacy, guiding therapeutic decisions, and preventing the development of drug resistance.

Ensuring optimal adherence to ART regimens in infants poses unique challenges. Limited formulations, difficulties in administration, and potential side effects can impact adherence. Collaborative efforts between healthcare

providers, caregivers, and support networks are crucial in overcoming these challenges and promoting consistent adherence to the prescribed treatment. In addition to ART, research is exploring immune-based interventions aimed at enhancing immune responses in infants with HIV [86]. Immunomodulatory agents and therapeutic vaccines are under investigation to mitigate immune activation, restore T-cell function, and contribute to sustained viral remission. These interventions hold promise for complementing traditional antiretroviral approaches. Comprehensive care for infants living with HIV extends beyond antiretroviral therapy. Supportive therapies, including nutritional support, treatment of co-infections, and immunizations, play a critical role in overall health and immune function. Addressing social determinants of health and promoting a supportive environment are integral components of a holistic therapeutic approach. Preventing vertical transmission through effective prevention of mother-to-child transmission (PMTCT) strategies is paramount [87]. Antenatal screening, timely initiation of maternal ART, avoidance of breastfeeding in specific settings, and prophylactic measures for infants born to HIV-positive mothers collectively contribute to reducing the risk of transmission and subsequent HIV infection in infants.

Conclusion

The immunological challenges faced by infants living with Human Immunodeficiency Virus (HIV) are complex and multifaceted, impacting their overall health and susceptibility to infections. This comprehensive review has explored key aspects of HIV infection in infants, including immune system development, viral persistence, chronic immune activation, immunodeficiency, and therapeutic interventions. The developing immune system of infants is significantly compromised by HIV, with implications for T-cell development, B-cell maturation, and overall immune function. This disruption sets the stage for persistent viral reservoirs and chronic immune activation, contributing to increased vulnerability to opportunistic infections. At the maternal-fetal interface, effective prevention strategies, including antenatal screening, timely initiation of ART in pregnant women, safe delivery practices, and antiretroviral prophylaxis for infants, play pivotal roles in reducing the risk of vertical transmission.

References

1. Adetokunboh OO, Oluwasanu M (2016) Eliminating mother-to-child transmission of the human immunodeficiency virus in sub-Saharan Africa: The journey so far and what remains to be done. Journal of infection and public health 9(4): 396-407.

2. Obeagu EI, Okwuanaso CB, Edoho SH, Obeagu GU (2022) Under-nutrition among HIV-exposed Uninfected Children: A Review of African Perspective. Madonna University journal of Medicine and Health Sciences 2(3): 120-127.

3. Obeagu EI, Alum EU, Obeagu GU (2023) Factors associated with prevalence of HIV among youths: A review of Africa perspective. Madonna University journal of Medicine and Health Sciences 3(1): 13-18.

4. Obeagu EI (2023) A Review of Challenges and Coping Strategies Faced by HIV/AIDS Discordant Couples. Madonna University journal of Medicine and Health Sciences 3(1): 7-12.

5. Obeagu EI, Obeagu GU (2023) An update on premalignant cervical lesions and cervical cancer screening services among HIV positive women. J Pub Health Nutri 6(2): 141.

6. Ezeoru VC, Enweani IB, Ochiabuto O, Nwachukwu AC, Ogbonna US, et al. (2021) Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha, Nigeria. Journal of Pharmaceutical Research International 33(4): 10-19.

7. Omo-Emmanuel UK, Chinedum OK, Obeagu EI (2017) Evaluation of laboratory logistics management information system in HIV/AIDS comprehensive health facilities in Bayelsa State, Nigeria. Int J Curr Res Med Sci 3(1): 21-38.

8. Obeagu EI, Obeagu GU, Musiimenta E, Bot YS, Hassan AO (2023) Factors contributing to low utilization of HIV counseling and testing services. Int J Curr Res Med Sci 9(2): 1-5.

9. Obeagu EI, Obeagu GU (2022) An update on survival of people living with HIV in Nigeria. J Pub Health Nutri 5(6): 129.

10. Offie DC, Obeagu EI, Akueshi C, Njab JE, Ekanem EE, et al. (2021) Facilitators and barriers to retention in HIV care among HIV infected MSM attending Community Health Center Yaba, Lagos Nigeria. Journal of Pharmaceutical Research International 33(52B): 10-19.

11. Obeagu EI, Ogbonna US, Nwachukwu AC, Ochiabuto O, Enweani IB, Ezeoru VC (2021) Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha, Nigeria. Journal of Pharmaceutical Research International. 33(4): 10-19.

12. Odo M, Ochei KC, Obeagu EI, Barinaadaa A, Eteng UE, et al. (2020) TB Infection Control in TB/HIV Settings in Cross River State, Nigeria: Policy Vs Practice. Journal

of Pharmaceutical Research International 32(22): 101-109.

13. Obeagu EI, Eze VU, Alaeboh EA, Ochei KC (2016) Determination of haematocrit level and iron profile study among persons living with HIV in Umuahia, Abia State, Nigeria. J BioInnovation 5(4): 464-471.

14. Ifeanyi OE, Obeagu GU (2015) The values of prothrombin time among HIV positive patients in FMC owerri. International Journal of Current Microbiology and Applied Sciences 4(4): 911-916.

15. Izuchukwu IF, Ozims SJ, Agu GC, Obeagu EI, Onu I, et al. (2016) 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 3(10): 55-65.

16. Kingston OU, Nonye O, Chinedu OK, Takim AE, Obeagu EI, et al. (2017) HIV and TB co-infection among patients who used Directly Observed Treatment Short-course centres in Yenagoa, Nigeria. IOSR J Pharm Biol Sci 12(4): 70-75.

17. Oloro OH, Oke TO, Obeagu EI (2022) 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 2(3): 110-119.

18. Nwosu DC, Obeagu EI, Nkwocha BC, Nwanna CA, Nwanjo HU, et al. (2016) 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 5(1): 24-30.

19. Igwe MC, Obeagu EI, Ogbuabor AO (2022) Clinical characteristics of people living with HIV/AIDS on ART in 2014 at tertiary health institutions in Enugu, Nigeria. J Pub Health Nutri 5(6): 130.

20. Ifeanyi OE, Obeagu GU, Ijeoma FO, Chioma UI (2015) The values of activated partial thromboplastin time (APTT) among HIV positive patients in FMC Owerri. Int J Curr Res Aca Rev 3: 139-144.

21. Favour OC, Ifeanyi OE, Chinedum OK, Abum SC, Ozioma AB (2018) Hematological indices of HIV seropositive subjects in Nnamdi Azikiwe University teaching hospital (NAUTH), Nnewi Ann Clin Lab Res 6(1): 1-4.

22. Omo-Emmanuel UK, Ochei KC, Osuala EO, Obeagu EI, Onwuasoanya UF (2017) Impact of prevention of mother to child transmission (PMTCT) of HIV on positivity rate in Kafanchan, Nigeria. Int J Curr Res Med Sci 3(2): 28-34.

23. Aizaz M, Abbas FA, Abbas A, Tabassum S, Obeagu EI (2023) Alarming rise in HIV cases in Pakistan: Challenges and future recommendations at hand. Health Science Reports 6(8): e1450.

24. Obeagu EI, Amekpor F, Scott GY, Okwuanaso CB (2023) An update of human immunodeficiency virus infection: Bleeding disorders. J Pub Health Nutri 6(1): 139.

25. Obeagu EI, Scott GY, Amekpor F, Ofodile AC, Edoho SH, et al. (2022) Prevention of New Cases of Human Immunodeficiency Virus: Pragmatic Approaches of Saving Life in Developing Countries. Madonna University journal of Medicine and Health Sciences 2(3): 128-134.

26. Okoroiwu IL, Obeagu EI, Anaebo QB, Walter O (2022) Evaluation of Activated Partial Thromboplastin Time and Prothrombin Time in HIV and TB Patients in Owerri Metropolis. Journal of Pharmaceutical Research International 34(3A): 29-34.

27. Odo M, Ochei KC, Obeagu EI, Barinaadaa A, Eteng EU, et al. (2020) 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 32(24): 9-18.

28. Jakheng SPE, Obeagu EI (2022) Seroprevalence of human immunodeficiency virus based on demographic and risk factors among pregnant women attending clinics in Zaria Metropolis, Nigeria. J Pub Health Nutri 5(6): 127.

29. Obeagu EI, Obeagu GU (2023) 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 10(9): 135-142.

30. Obeagu EI, Onuoha EC (2023) Tuberculosis among HIV Patients: A review of Prevalence and Associated Factors. Int J Adv Res Biol Sci 10(9): 128-134.

31. Obeagu EI, Ibeh NC, Nwobodo HA, Ochei KC, Iwegbulam CP (2017) Haematological indices of malaria patients coinfected with HIV in Umuahia. Int J Curr Res Med Sci 3(5): 100-104.

32. Jakheng SPE, Obeagu EI, Abdullahi IO, Jakheng EW, Chukwueze CM, et al. (2022) 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 13(2): 26-31.

33. Viola N, Kimono E, Nuruh N, Obeagu EI (2023) 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 3(2): 7-14.

34. Okorie HM, Ifeanyi OE, Henry OHC, Nchekwubedi CS (2020) 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 2(3): 180-183.

35. Ezugwu UM, Onyenekwe CC, Ukibe NR, Ahaneku JE, Onah CE, et al. (2021) 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 33(47A): 78-84.

36. Emannuel G, Martin O, Peter OS, Obeagu EI, Daniel K (2023) 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 6(1): 203-211.

37. Ye P, Kirschner DE, Kourtis AP (2004) The thymus during HIV disease: role in pathogenesis and in immune recovery. Current HIV research 2(2): 177-183.

38. Igwe MC, Obeagu EI, Ogbuabor AO, Eze GC, Ikpenwa JN, et al. (2022) 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 10(4): 1-7.

39. Vincent CCN, Obeagu EI, Agu IS, Ukeagu NC, Onyekachi-Chigbu AC (2021) Adherence to Antiretroviral Therapy among HIV/AIDS in Federal Medical Centre, Owerri. Journal of Pharmaceutical Research International 33(57A): 360-368.

40. Igwe MC, Obeagu EI, Ogbuabor AO (2022) 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 2(3): 42-57.

41. Madekwe CC, Madekwe CC, Obeagu EI (2022) Inequality of monitoring in Human Immunodeficiency Virus, Tuberculosis and Malaria: A Review. Madonna University journal of Medicine and Health Sciences 2(3): 6-15.

42. Echendu GE, Vincent CC, Ibebuike J, Asodike M, Naze N, et al. (2023) 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 10(8): 564-568.

43. Nwosu DC, Nwanjo HU, Okolie NJ, Ikeh K, Ajero CM, et al. (2015) Biochemical Alterations in Adult Hiv Patients on Antiretrqviral Therapy. World Journal of Pharmacy and Pharmaceutical Sciences 4(3): 153-160.

44. Obeagu EI, Obeagu GU (2015) Effect of CD4 Counts on Coagulation Parameters among HIV Positive Patients in Federal Medical Centre, Owerri, Nigeria. Int J Curr Res Biosci Plant Biol 2(4): 45-49.

45. Obeagu EI, Nwosu DC (2019) Adverse drug reactions in HIV/AIDS patients on highly active antiretro viral therapy: a review of prevalence. Int J Curr Res Chem Pharm Sci 6(12): 45-48.

46. Obeagu EI, Scott GY, Amekpor F, Obeagu GU (2023) Implications of CD4/CD8 ratios in Human Immunodeficiency Virus infections. Int J Curr Res Med Sci 9(2): 6-13.

47. Obeagu EI, Ochei KC, Okeke EI, Anode AC (2016) Assessment of the level of haemoglobin and erythropoietin in persons living with HIV in Umuahia. Int J Curr Res Med Sci 2(4): 29-33.

48. Ifeanyi OE, Obeagu GU (2015) The Values of CD4 Count, among HIV Positive Patients in FMC Owerri. Int J Curr Microbiol App Sci 4(4): 906-910.

49. Obeagu EI, Okeke EI, Anonde AC (2016) Evaluation of haemoglobin and iron profile study among persons living with HIV in Umuahia, Abia state, Nigeria. Int J Curr Res Biol Med 1(2): 1-5.

50. Alum EU, Ugwu OPC, Obeagu EI, Okon MB (2023) Curtailing HIV/AIDS Spread: Impact of Religious Leaders. Newport International Journal of Research in Medical Sciences (NIJRMS) 3(2): 28-31.

51. Obeagu EI, Obeagu GU, Paul-Chima UO (2023) Stigma Associated With HIV. AIDS: A Review. Newport International Journal of Public Health and Pharmacy (NIJPP) 3(2): 64-67.

52. Alum EU, Obeagu EI, Ugwu OP, Aja PM, Okon MB (2023) HIV Infection and Cardiovascular diseases: The obnoxious Duos. Newport International Journal of Research in Medical Sciences (NIJRMS) 3(2): 95-99.

53. Ibebuike JE, Nwokike GI, Nwosu DC, Obeagu EI (2018) 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 1(2): 8-14.

54. Obeagu EI, Obarezi TN, Omeh YN, Okoro NK, Eze OBL (2014) Assessment of some haematological and biochemical parametrs in HIV patients before receiving treatment in Aba, Abia State, Nigeria. Res J Pharma Biol Chem Sci 5(2): 825-830.

55. Obeagu EI, Obarezi TN, Ogbuabor BN, Anaebo QBN, Eze GC (2014) 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 3(1): 186-189.

56. Obeagu EI (2023) A Review of Challenges and Coping Strategies Faced by HIV/AIDS Discordant Couples. Madonna University journal of Medicine and Health Sciences 3(1): 7-12.

57. Oloro OH, Obeagu EI (2022) A Systematic Review on Some Coagulation Profile in HIV Infection. International Journal of Innovative and Applied Research 10(5): 1-11.

58. Nwosu DC, Obeagu EI, Nkwuocha BC, Nwanna CA, Nwanjo HU, et al. (2015) Alterations in superoxide dismutiase, vitamins C and E in HIV infected children in Umuahia, Abia state. International Journal of Advanced Research in Biological Sciences 2(11): 268-271.

59. Obeagu EI, Malot S, Obeagu GU, Ugwu OP (2023) HIV resistance in patients with Sickle Cell Anaemia. Newport International Journal of Scientific and Experimental Sciences (NIJSES) 3(2): 56-59.

60. Ifeanyi OE, Uzoma OG, Stella EI, Chinedum OK, Abum SC (2018) Vitamin D and insulin resistance in HIV sero positive individuals in Umudike. Int J Curr Res Med Sci 4(2): 104-108.

61. Ifeanyi OE, Leticia OI, Nwosu DC, Chinedum OK (2018) A Review on blood borne viral infections: universal precautions. Int J Adv Res Biol Sci 5(6): 60-66.

62. Nwovu AI, Ifeanyi OE, Uzoma OG, Nwebonyi NS (2018) 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 1(2).

63. Kingston OU, Nonye O, Chinedu OK, Takim AE, Obeagu EI, et al. (2017) HIV and TB co-infection among patients who used Directly Observed Treatment Short-course centres in Yenagoa, Nigeria. IOSR J Pharm Biol Sci 12(4): 70-75.

64. Offie DC, Obeagu EI, Akueshi C, Njab JE, Ekanem EE, et al. (2021) Facilitators and barriers to retention in HIV care among HIV infected MSM attending Community Health Center Yaba, Lagos Nigeria. Journal of Pharmaceutical Research International 33(52B): 10-19.

65. Obeagu EI, Obeagu GU, Ede MO, Odo EO, Buhari HA (2023) Translation of HIV/AIDS knowledge into behavior change among secondary school adolescents in Uganda: A review. Medicine (Baltimore) 102(49): e36599.

66. Anyiam AF, Arinze-Anyiam OC, Irondi EA, Obeagu EI (2023) Distribution of ABO and rhesus blood grouping with HIV infection among blood donors in Ekiti State Nigeria. Medicine (Baltimore) 102(47): e36342.

67. Echefu SN, Udosen JE, Akwiwu EC, Akpotuzor JO, Obeagu EI (2023) 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) 102(47): e35910.

68. Opeyemi AA, Obeagu EI (2023) Regulations of malaria in children with human immunodeficiency virus infection: A review. Medicine (Baltimore) 102(46): e36166.

69. Alum EU, Obeagu EI, Ugwu OPC, Samson AO, Adepoju AO, et al. (2023) Inclusion of nutritional counseling and mental health services in HIV/AIDS management: A paradigm shift. Medicine (Baltimore) 102(41): e35673.

70. Aizaz M, Abbas FA, Abbas A, Tabassum S, Obeagu EI (2023) Alarming rise in HIV cases in Pakistan: Challenges and future recommendations at hand. Health Sci Rep 6(8): e1450.

71. Obeagu EI, Obeagu GU, Obiezu J, Ezeonwumelu C, Ogunnaya FU, et al. (2023) Hematologic Support in HIV Patients: Blood Transfusion Strategies and Immunological Considerations. APPLIED SCIENCES (NIJBAS) 3(3).

72. Obeagu EI, Ubosi NI, Uzoma G (2023) Storms and Struggles: Managing HIV Amid Natural Disasters. Int J Curr Res Chem Pharm Sci 10(11): 14-25.

73. Obeagu EI, Obeagu GU (2023) Human Immunodeficiency Virus and tuberculosis infection: A review of prevalence of associated factors. Int J Adv Multidiscip Res 10(10): 56-62.

74. Obeagu EI, Malot S, Obeagu GU, Ugwu OP (2023) HIV resistance in patients with Sickle Cell Anaemia. Newport International Journal of Scientific and Experimental Sciences (NIJSES) 3(2): 56-59.

75. Alum EU, Ugwu OP, Obeagu EI, Aja PM, Okon MB, et al. (2023) Reducing HIV Infection Rate in Women: A

Catalyst to reducing HIV Infection pervasiveness in Africa. International Journal of Innovative and Applied Research 11(10): 1-6.

76. Kulpa DA, Chomont N (2015) HIV persistence in the setting of antiretroviral therapy: when, where and how does HIV hide?. Journal of virus eradication 1(2): 59-68.

77. Amin O, Powers J, Bricker KM, Chahroudi A (2021) Understanding viral and immune interplay during vertical transmission of HIV: implications for cure. Frontiers in Immunology 12: 757400.

78. Mzingwane ML, Tiemessen CT (2017) Mechanisms of HIV persistence in HIV reservoirs. Reviews in medical virology 27(2): e1924.

79. Berendam SJ, Nelson AN, Yagnik B, Goswami R, Styles TM, et al. (2022) Challenges and Opportunities of Therapies Targeting Early Life Immunity for Pediatric HIV Cure. Frontiers in Immunology 13: 885272.

80. Yi JS, Cox MA, Zajac AJ (2010) T-cell exhaustion: characteristics, causes and conversion. Immunology 129(4): 474-481.

81. Muenchhoff M, Prendergast AJ, Goulder PJR (2014) Immunity to HIV in early life. Frontiers in immunology 5: 391.

82. Février M, Dorgham K, Rebollo A (2011) CD4+ T cell depletion in human immunodeficiency virus (HIV) infection: role of apoptosis. Viruses 3(5): 586-612.

83. Govindaraj S, Babu H, Sidharthant S, Vaccari M, Petrovas C, et al. (2023) CD4+ T cells in HIV: A Friend or a Foe?. Frontiers in Immunology 14: 1203531.

84. Chinen J, Shearer WT (2010) Secondary immunodeficiencies, including HIV infection. Journal of Allergy and Clinical Immunology 125(2 Suppl 2): S195–S203.

85. Chen J, Ramendra R, Lu H, Routy J-P (2018) The early bird gets the worm: benefits and future directions with early antiretroviral therapy initiation in primary HIV infection. Future Virology 13(11): 779-786.

86. Lohman-Payne B, Slyker J, Rowland-Jones SL (2010) Immune-based approaches to the prevention of mother-to-child transmission of HIV-1: active and passive immunization. Clinics in perinatology 37(4): 787-ix.

87. Chi BH, Mbori-Ngacha D, Essajee S, Mofenson LM, Tsiouris F, et al. (2020) Accelerating progress towards the elimination of mother-to-child transmission of HIV: a narrative review. Journal of the International AIDS Society 23(8): e25571.