



Innate Immune Memory in HIV-Positive Sickle Cell Disease Patients

Emmanuel Ifeanyi Obeagu ^{1*} and Priya Homa Chukwu ²

¹ Department of Biomedical and Laboratory Science, Africa University, Zimbabwe

² Department of Haematology and Blood Transfusion Science, Faculty of Medical Laboratory Science, Rivers State University of Science and Technology, Port Harcourt, Rivers State, Nigeria

Article Info:

Article History:

Received 06 Jan 2025

Reviewed 05 Feb 2025

Accepted 01 March 2025

Published 15 June 2025

Cite this article as:

Obeagu EI, Chukwu PH, Innate Immune Memory in HIV-Positive Sickle Cell Disease Patients, Asian Journal of Dental and Health Sciences. 2025; 5(2):14-19

DOI: <http://dx.doi.org/10.22270/ajdhs.v5i2.126>

Abstract

Innate immune memory represents a crucial aspect of the immune response, particularly in individuals with chronic infections and genetic disorders such as HIV and sickle cell disease (SCD). This review explores the complex interplay between innate immune memory and the health outcomes of HIV-positive patients with SCD. The presence of both conditions leads to unique immune dysregulation characterized by heightened inflammation, altered innate immune cell functionality, and increased susceptibility to infections. The pathophysiology of innate immune memory in HIV-positive SCD patients is multifaceted, influenced by chronic inflammation, microbial translocation, and immune cell exhaustion. These factors can exacerbate the clinical manifestations of both diseases, resulting in recurrent infections, vaso-occlusive crises, and other complications. As innate immune cells acquire memory-like properties in response to persistent inflammatory stimuli, their functionality may be altered, impacting the overall immune response and treatment efficacy. Recognizing these implications is vital for developing targeted therapeutic strategies aimed at enhancing immune competence in this population.

Keywords: Innate Immune Memory, HIV, Sickle Cell Disease, Immune Response, Inflammation

*Address for Correspondence:

Emmanuel Ifeanyi Obeagu, Department of Biomedical and Laboratory Science, Africa University, Zimbabwe

Introduction

Sickle cell disease (SCD) and human immunodeficiency virus (HIV) infection are two significant health challenges that disproportionately affect individuals, particularly in sub-Saharan Africa and other resource-limited settings. SCD, a genetic disorder characterized by the production of abnormal hemoglobin S, leads to a range of complications, including painful vaso-occlusive crises, acute chest syndrome, and an increased risk of infections. Simultaneously, HIV infection results in progressive immune dysfunction, primarily through the depletion of CD4⁺ T cells, leading to a state of chronic immunosuppression. The coexistence of these two conditions presents unique clinical challenges, as the interactions between SCD and HIV can exacerbate disease complications and impact patient management.¹⁻² Innate immune memory is an emerging concept that describes the enhanced responsiveness of innate immune cells following prior exposure to pathogens. Unlike adaptive immunity, which relies on the activation of lymphocytes and the formation of memory cells, innate immune memory is characterized by the ability of innate immune cells, such as monocytes, macrophages, and natural killer (NK) cells, to "remember" previous encounters with pathogens. This phenomenon has been observed in various contexts,

including viral infections and chronic inflammatory diseases, and its relevance in the context of HIV and SCD remains a critical area of investigation. Understanding how innate immune memory functions in HIV-positive SCD patients may provide insights into their immune responses and susceptibility to infections.³⁻⁵ The impact of chronic inflammation on immune regulation in patients with SCD is well documented. Recurrent vaso-occlusive crises and tissue ischemia-reperfusion injury contribute to a pro-inflammatory state characterized by elevated levels of cytokines, chemokines, and other inflammatory mediators. This persistent inflammation not only affects the bone marrow and hematopoiesis but also alters the functionality of innate immune cells. In HIV-infected individuals, the inflammatory milieu may further disrupt immune homeostasis, leading to alterations in innate immune memory and responses. The interplay between these two conditions necessitates a deeper understanding of their combined effects on innate immune function.⁶⁻⁷

Emerging evidence suggests that innate immune memory may play a role in shaping the clinical outcomes of HIV-positive SCD patients. The altered functionality of innate immune cells, coupled with the chronic inflammatory state, may influence susceptibility to opportunistic infections and the severity of SCD-

related complications. Additionally, the presence of HIV may exacerbate the immune dysregulation associated with SCD, leading to a cycle of inflammation and immune dysfunction. Investigating the prevalence and mechanisms of innate immune memory in this population could uncover potential therapeutic targets and improve clinical management strategies.⁸⁻⁹ Furthermore, the role of microbial translocation in HIV-positive individuals may contribute to the development of innate immune memory. Gut barrier dysfunction, common in HIV infection, allows the translocation of microbial products into the bloodstream, triggering systemic inflammation and innate immune activation. This process can perpetuate immune activation and alter the characteristics of innate immune cells, potentially influencing their memory-like properties.¹⁰⁻¹¹ Current management approaches for HIV-positive patients with SCD must address the complexities associated with both conditions. Tailoring treatment strategies to account for the altered immune responses and increased risk of infections is essential for optimizing patient outcomes. The integration of immunomodulatory therapies, lifestyle modifications, and preventive measures can enhance immune competence and reduce complications in this population. However, a thorough understanding of the mechanisms underpinning innate immune memory is necessary to inform the development of such strategies.¹²⁻¹³

Prevalence of Innate Immune Memory in HIV-Positive Sickle Cell Disease Patients

The prevalence of innate immune memory in HIV-positive sickle cell disease (SCD) patients is an area of emerging research that highlights the complex immunological interactions between these two conditions. While specific studies directly addressing the prevalence of innate immune memory in this unique population are limited, available data on individual conditions provide important insights. Sickle cell disease is characterized by chronic inflammation and repeated vaso-occlusive crises, which can significantly affect innate immune cell function. Concurrently, HIV infection leads to a state of immune dysregulation marked by persistent inflammation, immune activation, and alterations in the population and functionality of innate immune cells.¹⁴⁻¹⁶ Research has shown that HIV infection induces changes in innate immune cells, including monocytes and macrophages, which can exhibit memory-like responses following exposure to inflammatory stimuli or pathogens. These changes may manifest as enhanced cytokine production and altered surface marker expression, suggesting a degree of innate immune memory. In the context of SCD, the chronic inflammatory state may further amplify these responses, leading to an increased prevalence of innate immune memory features among HIV-positive SCD patients. For instance, elevated levels of pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α) in SCD patients may prime innate immune cells, enhancing their responsiveness to subsequent inflammatory challenges.¹⁷⁻¹⁹

Studies investigating the effects of SCD on immune function have demonstrated that patients with SCD often experience increased immune activation and altered innate immune cell profiles. This may contribute to a heightened state of innate immune memory, as seen in patients with chronic infections. However, the direct impact of HIV on the prevalence of innate immune memory in SCD patients remains less clear, requiring further exploration. Research focusing on the interactions between SCD and HIV, particularly in terms of immune responses, is essential to determine the prevalence and significance of innate immune memory in this dual population.²⁰⁻²¹ Moreover, the prevalence of innate immune memory in HIV-positive SCD patients can also be influenced by various factors, including disease severity, treatment regimens, and the presence of comorbid conditions. For example, antiretroviral therapy (ART) has been shown to reduce systemic inflammation and restore some aspects of immune function in HIV-infected individuals, potentially impacting the development of innate immune memory. Understanding how these variables affect innate immune responses in the context of HIV and SCD is crucial for improving management strategies and patient outcomes.²²⁻²³

Pathophysiology of Innate Immune Memory in HIV-Positive Sickle Cell Disease Patients

The pathophysiology of innate immune memory in HIV-positive sickle cell disease (SCD) patients is a complex interplay of genetic, immunological, and environmental factors that contribute to altered immune responses. Innate immune memory is characterized by the enhanced responsiveness of innate immune cells, such as monocytes, macrophages, and natural killer (NK) cells, following exposure to pathogens or inflammatory stimuli. In the context of HIV infection and SCD, this phenomenon is exacerbated by chronic inflammation, immune dysregulation, and the unique clinical manifestations of both conditions.²⁴⁻²⁵ Sickle cell disease is associated with a state of chronic inflammation resulting from recurrent vaso-occlusive crises, tissue damage, and hemolysis. The release of pro-inflammatory mediators, such as cytokines and chemokines, perpetuates an inflammatory environment that can significantly affect the functionality of innate immune cells. For instance, elevated levels of interleukin-1 (IL-1), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- α) are commonly observed in SCD patients, leading to the activation of immune pathways and the priming of innate immune cells. This persistent inflammatory state can promote the development of innate immune memory features, resulting in an exaggerated response to subsequent infections or inflammatory triggers.²⁶⁻²⁷

In individuals living with HIV, the virus leads to chronic immune activation and the depletion of CD4⁺ T cells, which can further disrupt immune homeostasis. The depletion of T cells reduces the regulatory capacity of the immune system, resulting in increased activation of innate immune cells. This dysregulation can lead to changes in the expression of surface markers, cytokine

production, and overall functionality of innate immune cells. For example, monocytes and macrophages from HIV-infected individuals often exhibit an increased production of inflammatory cytokines and altered phagocytic activity. These changes can enhance the memory-like characteristics of innate immune cells, potentially increasing susceptibility to opportunistic infections and other complications.²⁸⁻²⁹ The interaction between HIV and SCD complicates the pathophysiology of innate immune memory. The presence of both conditions can create a vicious cycle of inflammation and immune activation, further altering the functionality of innate immune cells. For instance, HIV infection may exacerbate the inflammatory responses observed in SCD, while the chronic inflammatory state of SCD can enhance the immune dysregulation caused by HIV. This interplay may lead to a unique profile of innate immune memory that differs from individuals with either condition alone.³⁰ Additionally, microbial translocation is a critical factor in the pathophysiology of innate immune memory in HIV-positive SCD patients. HIV infection often leads to gut barrier dysfunction, allowing microbial products to enter the bloodstream and trigger systemic inflammation. This process can activate innate immune cells, promoting the development of memory-like characteristics and exacerbating immune activation. The combination of chronic inflammation from SCD and microbial translocation in HIV-infected individuals highlights the complexity of the immune landscape in this population.³¹⁻³² The consequences of altered innate immune memory in HIV-positive SCD patients can significantly impact clinical outcomes. Enhanced innate immune responses may contribute to increased susceptibility to infections, recurrent crises, and other complications associated with both conditions.³³

Clinical Manifestations and Implications

The clinical manifestations of innate immune memory in HIV-positive sickle cell disease (SCD) patients are multifaceted and can significantly impact disease outcomes, patient management, and overall quality of life. The interaction between chronic inflammation, immune dysregulation, and the unique characteristics of both HIV and SCD can lead to several complications that require careful monitoring and intervention.³⁴ One of the most prominent clinical manifestations in HIV-positive SCD patients is an increased susceptibility to infections. The altered innate immune responses associated with innate immune memory can lead to an enhanced inflammatory response, which, while initially protective, may ultimately prove detrimental. This hyper-inflammatory state can result in complications such as recurrent bacterial infections, opportunistic infections, and other infectious diseases that are more common in immunocompromised individuals. For example, patients may experience frequent episodes of pneumonia, urinary tract infections, and skin infections, necessitating aggressive antibiotic therapy and increased healthcare utilization.³⁵⁻³⁶ Another significant clinical manifestation is the exacerbation of SCD-related complications, including vaso-occlusive crises and acute chest syndrome. The presence of innate immune

memory may influence the severity and frequency of these complications. Increased inflammatory cytokines can contribute to vasculopathy and endothelial dysfunction, leading to more severe pain crises and complications associated with acute chest syndrome.³⁷ In addition to infection and SCD-related complications, the psychological and social implications of living with both HIV and SCD can profoundly affect patients' quality of life. Chronic health issues and the associated stigma of HIV can lead to significant emotional distress, anxiety, and depression. The interplay between these conditions may exacerbate the psychological burden, as patients may struggle with the implications of their dual diagnoses and the ongoing management of their health. Addressing these psychosocial aspects is essential for comprehensive patient care and improving overall well-being.³⁸ The impact of innate immune memory on treatment strategies in HIV-positive SCD patients is another critical consideration. The complex interplay of immune responses necessitates a tailored approach to therapy, including the use of antiretroviral therapy (ART) and other immunomodulatory treatments. While ART can help restore some aspects of immune function in HIV-infected individuals, its effects on innate immune memory in the context of SCD require further investigation. Optimizing treatment regimens to consider the unique immunological landscape of this population may enhance therapeutic outcomes and reduce complications.³⁹ Furthermore, the presence of innate immune memory may also influence vaccine responses in HIV-positive SCD patients. Vaccination is an essential component of preventive healthcare for this population, given their increased susceptibility to infections. However, the effectiveness of vaccines may be compromised by the underlying immune dysregulation associated with both HIV and SCD.⁴⁰

Management Strategies and Therapeutic Implications

Managing innate immune memory in HIV-positive sickle cell disease (SCD) patients requires a multifaceted approach that addresses the unique challenges posed by the interplay of these two chronic conditions. Effective management strategies must focus on reducing the risk of infections, mitigating inflammatory responses, and enhancing overall immune function. A comprehensive treatment plan should include pharmacological interventions, lifestyle modifications, and preventive measures tailored to the individual patient's needs.⁴¹ Pharmacological management primarily involves the use of antiretroviral therapy (ART) for HIV-infected patients. ART has been shown to reduce viral load, restore CD4+ T cell counts, and improve immune function. However, its role in modulating innate immune memory in SCD patients is not fully understood. Future research should investigate the optimal ART regimens that not only effectively manage HIV but also positively influence the innate immune response in the context of SCD. Additionally, incorporating anti-inflammatory agents, such as corticosteroids or non-steroidal anti-inflammatory drugs (NSAIDs), may help alleviate the chronic inflammation associated with SCD and potentially

mitigate some of the adverse effects of innate immune memory.⁴² In addition to pharmacological treatments, vaccination plays a crucial role in preventing infections in this vulnerable population. Given the altered immune responses associated with innate immune memory, careful consideration must be given to vaccine selection and administration. Standard vaccinations, such as those for influenza, pneumococcus, and hepatitis B, are essential, but the efficacy of these vaccines in HIV-positive SCD patients may be compromised. Ongoing research is necessary to evaluate the immunogenicity of vaccines in this group and to determine optimal vaccination strategies to ensure adequate protection against infectious diseases.⁴³

Lifestyle modifications can also significantly impact the management of innate immune memory in HIV-positive SCD patients. Encouraging a healthy diet, regular physical activity, and proper hydration can help improve overall health and potentially enhance immune function. Moreover, patient education on the importance of adherence to ART and routine healthcare visits is vital for preventing complications and managing comorbidities. Addressing psychosocial factors, such as providing mental health support and counseling, can also contribute to better health outcomes by reducing stress and improving quality of life.⁴⁴ Regular monitoring and surveillance of immune function and overall health are critical components of management strategies for HIV-positive SCD patients. Healthcare providers should consider implementing routine assessments of immune markers, inflammatory cytokines, and overall disease burden. This approach can help identify patients at higher risk for infections and complications, allowing for timely interventions and adjustments to treatment plans as necessary.⁴⁵ Therapeutic implications of understanding innate immune memory in this population extend beyond managing infections. The recognition that innate immune memory may influence the severity and frequency of vaso-occlusive crises and acute chest syndrome highlights the need for targeted therapies aimed at modulating inflammatory responses. For example, research into the use of monoclonal antibodies or other immunomodulatory agents may provide new avenues for managing inflammation and improving clinical outcomes in HIV-positive SCD patients.⁴⁶

Challenges and Future Directions

The management of innate immune memory in HIV-positive sickle cell disease (SCD) patients presents numerous challenges that hinder optimal patient care and outcomes. One of the primary challenges is the complexity of the interactions between HIV, SCD, and the immune system. The dual burden of chronic infection and a genetic disorder results in a unique immunological landscape that is not yet fully understood. This complexity complicates the development of targeted therapeutic strategies and effective management protocols tailored to this population. Another significant challenge is the variability in patient responses to treatments. Factors such as genetic background, the severity of HIV and SCD,

and the presence of comorbidities can all influence how patients respond to therapies. The existence of innate immune memory may further contribute to this variability, leading to unpredictable outcomes in terms of infection susceptibility and inflammatory responses. Identifying biomarkers that can predict treatment responses and individualize therapeutic approaches will be essential for improving outcomes in HIV-positive SCD patients.⁴⁷ Furthermore, the current body of research on innate immune memory in HIV-positive SCD patients is limited, leading to a knowledge gap regarding the mechanisms underlying this phenomenon. Much of the existing literature has focused on either HIV or SCD in isolation, with relatively few studies examining their combined effects on innate immunity. Future research must prioritize understanding the interactions between these two conditions, particularly how innate immune memory influences disease progression, treatment responses, and the risk of complications. Addressing the psychosocial aspects of living with both HIV and SCD is another critical challenge. Patients may experience increased stigma, anxiety, and depression, which can adversely affect treatment adherence and overall health outcomes. Incorporating mental health support and counseling into standard care for HIV-positive SCD patients is vital for improving quality of life and ensuring better management of both conditions.⁴⁸

In terms of future directions, there is a pressing need for interdisciplinary research that brings together experts in immunology, hematology, infectious diseases, and mental health to develop comprehensive management strategies. Collaborative research efforts can lead to a deeper understanding of the pathophysiology of innate immune memory in this unique population and drive innovations in treatment approaches. For instance, studies exploring novel immunomodulatory therapies that target chronic inflammation and restore immune function may hold promise for improving health outcomes in HIV-positive SCD patients.⁴⁷ Moreover, advancements in personalized medicine and genomic technologies present exciting opportunities for optimizing treatment strategies. By identifying genetic markers associated with immune responses, researchers can develop tailored therapeutic interventions that address the specific needs of HIV-positive SCD patients. Additionally, the exploration of novel vaccination strategies, including mRNA vaccines and adjuvants that enhance immune responses, could provide new avenues for preventing infections in this vulnerable population.⁴⁸

Conclusion

Innate immune memory in HIV-positive sickle cell disease (SCD) patients presents a complex interplay of immunological factors that significantly impacts disease management and patient outcomes. The chronic inflammation associated with both conditions can lead to heightened susceptibility to infections, exacerbation of SCD-related complications, and challenges in treatment responses. As healthcare providers navigate the intricacies of managing these patients, it becomes evident that a comprehensive understanding of innate

immune memory is essential for optimizing therapeutic strategies. Despite the challenges presented by this dual burden, there are promising avenues for future research and intervention. Ongoing studies aimed at elucidating the mechanisms underlying innate immune memory in this population will be crucial in identifying targeted therapies and improving treatment outcomes. Additionally, a focus on personalized medicine, psychosocial support, and interdisciplinary collaboration will be essential in addressing the unique needs of HIV-positive SCD patients.

Conflict of Interest: Author declares no potential conflict of interest with respect to the contents, authorship, and/or publication of this article.

Source of Support: Nil

Funding: The authors declared that this study has received no financial support.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data supporting in this paper are available in the cited references.

Ethics approval: Not applicable.

References

- Owusu ED, Visser BJ, Nagel IM, Mens PF, Grobusch MP. The interaction between sickle cell disease and HIV infection: a systematic review. *Clinical Infectious Diseases*. 2015; 60(4):612-626. <https://doi.org/10.1093/cid/ciu832> PMID:25344542
- Boateng LA, Ngoma AM, Bates I, Schonewille H. Red blood cell alloimmunization in transfused patients with sickle cell disease in sub-Saharan Africa; a systematic review and meta-analysis. *Transfusion Medicine Reviews*. 2019; 33(3):162-169. <https://doi.org/10.1016/j.tmr.2019.06.003> PMID:31345590
- Ola B, Olushola O, Ebenso B, Berghs M. Sickle Cell Disease and Its Psychosocial Burdens in Africa. In *Sickle Cell Disease in Sub-Saharan Africa 2024*: 67-80. Routledge. <https://doi.org/10.4324/9781003467748-7>
- Obeagu EI, Reducing Hospitalization Rates: The Preventive Benefits of Blood Transfusions in HIV Care, *International Journal of Medical Sciences and Pharma Research*, 2024;10(3):29-34 <https://doi.org/10.22270/ijmspr.v10i3.111>
- Ochocinski D, Dalal M, Black LV, Carr S, Lew J, Sullivan K, Kissoon N. Life-threatening infectious complications in sickle cell disease: a concise narrative review. *Frontiers in Pediatrics*. 2020; 8:38. <https://doi.org/10.3389/fped.2020.00038> PMID:32154192 PMCID:PMC7044152
- Obeagu EI, Obeagu GU, Okwuanaso CB. Optimizing Immune Health in HIV Patients through Nutrition: A Review. *Elite Journal of Immunology*, 2024; 2(1): 14-33
- 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).
- Obeagu EI, Ubosi NI, Obeagu GU, Akram M. Early Infant Diagnosis: Key to Breaking the Chain of HIV Transmission. *Elite Journal of Public Health*, 2024; 2 (1): 52-61
- Obeagu EI, Obeagu GU. Hematocrit Fluctuations in HIV Patients Co-infected with Malaria Parasites: A Comprehensive Review. *Int. J. Curr. Res. Med. Sci*. 2024; 10(1):25-36. <https://doi.org/10.22270/ijmspr.v10i2.95>
- Obeagu EI, Obeagu GU. Transfusion Therapy in HIV: Risk Mitigation and Benefits for Improved Patient Outcomes. *Asian J. Dental Health Sci*, 2024; 4(1):32-7. <https://doi.org/10.22270/ajdhs.v4i1.62>
- Obeagu EI, Obeagu GU. Advancements in HIV Prevention: Africa's Trailblazing Initiatives and Breakthroughs. *Elite Journal of Public Health*, 2024; 2 (1): 52-63
- Obeagu EI, Obeagu GU. Optimizing Blood Transfusion Protocols for Breast Cancer Patients Living with HIV: A Comprehensive Review. *Elite Journal of Nursing and Health Science*, 2024; 2(2):1-17
- Obeagu EI, Obeagu GU. Understanding ART and Platelet Functionality: Implications for HIV Patients. *Elite Journal of HIV*, 2024; 2(2): 60-73 1
- Obeagu EI, Obeagu GU. Hematologic Considerations in Breast Cancer Patients with HIV: Insights into Blood Transfusion Strategies. *Elite Journal of Health Science*, 2024; 2(2): 20- 35
- Obeagu EI, Obeagu GU. Impact of Maternal Eosinophils on Neonatal Immunity in HIVExposed Infants: A Review. *Elite Journal of Immunology*, 2024; 2(3): 1-18 <https://doi.org/10.22270/ajdhs.v4i2.82>
- 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. *Newport International Journal of Biological and Applied Sciences (NIJBAS)* 2023. <http://hdl.handle.net/20.500.12493/14626>
- Ntsekhe M, Baker JV. Cardiovascular disease among persons living with HIV: new insights into pathogenesis and clinical manifestations in a global context. *Circulation*. 2023; 147(1):83-100. <https://doi.org/10.1161/CIRCULATIONAHA.122.057443> PMID:36576956
- Obare LM, Temu T, Mallal SA, Wanjalla CN. Inflammation in HIV and its impact on atherosclerotic cardiovascular disease. *Circulation research*. 2024; 134(11):1515-1545 <https://doi.org/10.1161/CIRCRESAHA.124.323891> PMID:38781301 PMCID:PMC11122788
- Hmiel L, Zhang S, Obare LM, Santana MA, Wanjalla CN, Titanji BK, Hileman CO, Bagchi S. Inflammatory and immune mechanisms for atherosclerotic cardiovascular disease in HIV. *International journal of molecular sciences*. 2024; 25(13):7266. <https://doi.org/10.3390/ijms25137266> PMID:39000373 PMCID:PMC11242562
- Obeagu EI, Obeagu GU. Platelet Aberrations in HIV Patients: Assessing Impacts of ART. *Elite Journal of Haematology*, 2024; 2(3): 10-24
- Obeagu EI, Obeagu GU. Harnessing B Cell Responses for Personalized Approaches in HIV Management. *Elite Journal of Immunology*, 2024; 2(2): 15-28
- Belisário AR, Błatyta PF, Vivanco D, Oliveira CD, Carneiro-Proietti AB, Sabino EC, de Almeida-Neto C, Loureiro P, Máximo C, de Oliveira Garcia Mateos S, Flor-Park MV. Association of HIV infection with clinical and laboratory characteristics of sickle cell disease. *BMC Infectious Diseases*. 2020; 20(1):638. <https://doi.org/10.1186/s12879-020-05366-z> PMID:32854639 PMCID:PMC7457248
- Obeagu EI, Addressing Sleep Disturbances: Blood Transfusions and Improved Sleep Patterns in HIV Patients, *International Journal of Medical Sciences and Pharma Research*, 2024;10(3):43-48 <https://doi.org/10.22270/ijmspr.v10i3.113>
- Gill AF, Ahsan MH, Lackner AA, Veazey RS. Hematologic abnormalities associated with simian immunodeficiency virus (SIV) infection mimic those in HIV infection. *Journal of Medical Primatology*. 2012; 41(3):214-224. <https://doi.org/10.1111/j.1600-0684.2012.00543.x> PMID:22620272 PMCID:PMC3367385
- Nouraei M, Nekhai S, Gordeuk VR. Sickle cell disease is associated with decreased HIV but higher HBV and HCV comorbidities in US hospital discharge records: a cross-sectional study. *Sexually transmitted infections*. 2012; 88(7):528-533. <https://doi.org/10.1136/sextrans-2011-050459> PMID:22628662 PMCID:PMC3456988

26. Obeagu EI, Obeagu GU. Hematological Changes Following Blood Transfusion in Young Children with Severe Malaria and HIV: A Critical Review. *Elite Journal of Laboratory Medicine*. 2024; 2(1):33-45.
27. Obeagu EI, Obeagu GU. The Role of L-selectin in Tuberculosis and HIV Coinfection: Implications for Disease Diagnosis and Management. *Elite Journal of Public Health*, 2024; 2 (1): 35-51
28. Obeagu EI, Obeagu GU. Unraveling the Role of Eosinophil Extracellular Traps (EETs) in HIV-Infected Pregnant Women: A Review. *Elite Journal of Nursing and Health Science*, 2024; 2(3): 84-99
29. Obeagu EI, Obeagu GU. Unveiling the Role of Innate Immune Activation in Pediatric HIV: A Review. *Elite Journal of Immunology*, 2024; 2(3): 33-44
30. Obeagu EI, Obeagu, GU. Impact of Blood Transfusion on Viral Load Dynamics in HIVPositive Neonates with Severe Malaria: A Review. *Elite Journal of Scientific Research and Review*, 2024; 2(1): 42-60
31. Obeagu EI, Youth-Friendly HIV Prevention: Tailoring Interventions for Young Populations, *International Journal of Medical Sciences and Pharma Research*, 2024;10(4):62-67.
<https://doi.org/10.22270/ijmspr.v10i4.125>
32. Obeagu EI, Faith-based initiatives, HIV awareness, religious communities, health education, stigma reduction, *International Journal of Medical Sciences and Pharma Research*, 2024;10(4):74-79 <https://doi.org/10.22270/ijmspr.v10i4.127>
33. Obeagu EI, Obeagu GU. P-Selectin Expression in HIV-Associated Coagulopathy: Implications for Treatment. *Elite Journal of Haematology*, 2024; 2(3): 25-41
34. Obeagu EI, Obeagu GU. P-Selectin and Immune Activation in HIV: Clinical Implications. *Elite Journal of Health Science*, 2024; 2(2): 16-29
35. Obeagu EI, Amaeze AA, Ogbu ISI, Obeagu GU. B Cell Deficiency and Implications in HIV Pathogenesis: Unraveling the Complex Interplay. *Elite Journal of Nursing and Health Science*, 2024; 2(2): 33-46
36. Obeagu EI, Obeagu, GU. Platelet Dysfunction in HIV Patients: Assessing ART Risks. *Elite Journal of Scientific Research and Review*, 2024; 2(1): 1-16
37. Kibaru EG, Nduati R, Wamalwa D, Kariuki N. Impact of highly active antiretroviral therapy on hematological indices among HIV-1 infected children at Kenyatta National Hospital-Kenya: retrospective study. *AIDS research and therapy*. 2015; 12:1-8.
<https://doi.org/10.1186/s12981-015-0069-4> PMID:26279668
PMCID:PMC4537535
38. Enawgaw B, Alem M, Addis Z, Melku M. Determination of hematological and immunological parameters among HIV positive patients taking highly active antiretroviral treatment and treatment naïve in the antiretroviral therapy clinic of Gondar University Hospital, Gondar, Northwest Ethiopia: a comparative cross-sectional study. *BMC hematology*. 2014; 14:1-7.
<https://doi.org/10.1186/2052-1839-14-8> PMID:24666771
PMCID:PMC3994311
39. Gudina A, Wordofa M, Urgessa F. Immuno-hematological parameters among adult HIV patients before and after initiation of Dolutegravir based antiretroviral therapy, Addis Ababa, Ethiopia. *Plos one*. 2024; 19(10):e0310239.
<https://doi.org/10.1371/journal.pone.0310239> PMID:39480901
PMCID:PMC11527299
40. Geletaw T, Tadesse MZ, Demisse AG. Hematologic abnormalities and associated factors among HIV infected children pre-and post-antiretroviral treatment, North West Ethiopia. *Journal of blood medicine*. 2017:99-105. <https://doi.org/10.2147/JBM.S137067>
PMid:28831276 PMCID:PMC5552149
41. Jegede FE, Oyeyi TI, Abdulrahman SA, Mbah HA, Badru T, Agbakwuru C, Adedokun O. Effect of HIV and malaria parasites co-infection on immune-hematological profiles among patients attending anti-retroviral treatment (ART) clinic in Infectious Disease Hospital Kano, Nigeria. *PLoS One*. 2017; 12(3):e0174233.
<https://doi.org/10.1371/journal.pone.0174233> PMID:28346490
PMCID:PMC5367709
42. Obeagu EI, Obeagu GU. ART and Platelet Dynamics: Assessing Implications for HIV Patient Care. *Elite Journal of Haematology*. 2024; 2(4):68-85.
43. Obeagu EI, Ayogu EE, Obeagu GU. Impact on Viral Load Dynamics: Understanding the Interplay between Blood Transfusion and Antiretroviral Therapy in HIV Management. *Elite Journal of Nursing and Health Science*. 2024;2(2):5-15.
44. Ciccacci F, Lucaroni F, Latagliata R, Morciano L, Mondlane E, Balama M, Tembo D, Gondwe J, Orlando S, Palombi L, Marazzi MC. Hematologic alterations and early mortality in a cohort of HIV positive African patients. *PLoS One*. 2020; 15(11):e0242068.
<https://doi.org/10.1371/journal.pone.0242068> PMID:33170905
PMCID:PMC7654783
45. Ashenafi G, Tibebe M, Tilahun D, Tsegaye A. Immunohematological Outcome Among Adult HIV Patients Taking Highly Active Antiretroviral Therapy for at Least Six Months in Yabelo Hospital, Borana, Ethiopia. *Journal of Blood Medicine*. 2023:543-554.
<https://doi.org/10.2147/JBM.S419414> PMID:37881654
PMCID:PMC10595970
46. Obeagu EI, Goryacheva OG. The Role of Inflammation in HIV and Sickle Cell Disease Co-Morbidity. *Lifeline HIV*, 2025; 3(1): 1-12
47. Obeagu EI, Goryacheva OG. Oxidative Stress in HIV and Sickle Cell Disease: A Double Burden. *Lifeline HIV*, 2025; 3(1): 13-24
48. Obeagu EI, Goryacheva OG. HIV and Sickle Cell Disease: A Focus on Liver Dysfunction. *Lifeline HIV*, 2025; 3(1): 25-40