www.idosr.org Nyakairu, 2026
©IDOSR PUBLICATIONS ISSN: 2579-0730

International Digital Organization for Scientific Research IDOSR JBCP/26/102.1700
IDOSR JOURNAL OF BIOLOGY, CHEMISTRY AND PHARMACY 11(1):93-98, 2026.
https://doi.org/10.59298/IDOSR/JBCP/26/102.9398

Broadly Neutralizing Antibodies for HIV Prevention and Treatment: Advances and Challenges

Nyakairu Doreen G.

Faculty of Science and Technology Kampala International University Uganda

ABSTRACT

Human immunodeficiency virus continued to present a formidable global health challenge despite advances in antiretroviral therapy. Broadly neutralizing antibodies represent a unique class of immunoglobulins capable of recognizing conserved epitopes across diverse HIV strains, offering potential for both prevention and therapeutic intervention. These antibodies target critical viral envelope structures including the CD4 binding site, membrane proximal external region, V1V2 apex, and V3 glycan supersite, achieving viral neutralization through interference with host cell entry mechanisms. This review aimed to critically evaluate the biochemical properties, mechanisms of action, clinical efficacy, and translational challenges associated with broadly neutralizing antibodies in HIV prevention and treatment applications. A comprehensive synthesis of peer reviewed literature examining broadly neutralizing antibody discovery, structural biology, preclinical studies, clinical trials, and implementation barriers was conducted. Broadly neutralizing antibodies demonstrated potent in vitro neutralization of diverse HIV isolates and provide protection against viral acquisition in animal models. Clinical trials revealed promising pharmacokinetics with extended half-lives, modest virological suppression when used as monotherapy, and synergistic potential when combined with antiretroviral agents. Passive immunization studies indicated protective efficacy for prevention, though viral escape through envelope sequence variation remains problematic. Antibody engineering approaches including Fc modification and bispecific formats enhance potency and breadth. However, challenges persist regarding high production costs, need for intravenous or subcutaneous administration, resistance development, and limited accessibility in resource constrained settings. Broadly neutralizing antibodies constituted a valuable addition to HIV prevention and treatment strategies, though substantial barriers to widespread implementation require resolution through continued technological innovation and health system adaptations.

Keywords: Broadly neutralizing antibodies, Human immunodeficiency virus, Passive immunization, Viral envelope glycoproteins, Antiretroviral strategies.

INTRODUCTION

Human immunodeficiency virus infection remains a global public health priority, with approximately 38 million individuals living with the virus worldwide and continued transmission despite expanded antiretroviral therapy access [1, 2]. The virus exhibits extraordinary genetic diversity, with rapid mutation rates driven by error prone reverse transcriptase activity and high replication rates generating quasispecies populations within infected individuals [3]. This genetic variability, combined with extensive glycosylation of envelope proteins that shields epitopes from immune recognition, has historically thwarted vaccine development efforts and complicated therapeutic approaches. Broadly neutralizing antibodies represent a distinct class of humoral immune effectors that overcome these challenges by targeting functionally conserved regions of the viral envelope glycoprotein complex essential for viral entry [4, 5]. These antibodies develop naturally in approximately 10 to 30 percent of chronically infected individuals after several years of infection, arising through prolonged affinity maturation processes involving extensive somatic hypermutation. The biochemical characteristics enabling broad neutralization include exceptional binding affinity, often in picomolar ranges, elongated heavy chain complementarity determining regions capable of penetrating the glycan shield, and recognition of quaternary epitopes formed only in the native trimeric envelope configuration.

The potential application of broadly neutralizing antibodies extends beyond natural immune responses to encompass passive immunization strategies for both prevention and treatment [6]. Unlike conventional antiretroviral drugs

that target viral enzymes or entry coreceptors, these antibodies directly engage envelope glycoproteins, preventing virion attachment and membrane fusion while potentially mediating additional antiviral effects through Fc receptor interactions that promote infected cell clearance [7]. Preclinical studies in nonhuman primate models demonstrate that passive transfer of broadly neutralizing antibodies can prevent viral acquisition when administered before challenge and suppress viremia in established infections. Clinical translation has advanced through identification of increasingly potent antibodies, structural elucidation of epitope targets guiding rational optimization, and bioengineering modifications extending serum half-lives to enable practical dosing intervals. However, the transition from proof-of-concept studies to scalable prevention and treatment modalities confronts substantial obstacles including manufacturing complexity, delivery logistics, viral escape kinetics, and economic feasibility. The objective of this review is to critically examine the molecular mechanisms, clinical efficacy data, and implementation challenges associated with broadly neutralizing antibodies for HIV prevention and treatment, while identifying research priorities for advancing their therapeutic potential.

Molecular Mechanisms and Epitope Targets

Broadly neutralizing antibodies achieve their remarkable breadth of viral neutralization through recognition of conserved epitopes on the HIV envelope glycoprotein complex, which comprises trimeric gp120 and gp41 subunits mediating viral entry [8, 9]. Five major epitope classes have been extensively characterized, each presenting distinct biochemical features and neutralization mechanisms. The CD4 binding site, representing the region where viral gp120 engages the primary cellular receptor CD4, constitutes a functionally constrained target with limited tolerance for mutation [10]. Antibodies targeting this site, including VRC01 and its derivatives, utilize heavy chain complementarity determining region 2 to mimic CD4 interactions, achieving neutralization breadth exceeding 90 percent of circulating strains [11]. However, the recessed nature of this epitope necessitates antibodies with long complementarity determining regions capable of penetrating surrounding glycans, explaining the extensive somatic hypermutation required for such antibodies to develop naturally.

The V1V2 apex epitope, located at the trimer apex formed by variable loops 1 and 2, represents a quaternary structure dependent target recognized by antibodies such as PG9 and PGT145 [12]. These antibodies bind glycan dependent epitopes, interacting simultaneously with protein residues and complex N linked glycans, particularly the conserved N160 glycan. Neutralization occurs through stabilization of the closed prefusion envelope conformation, preventing the conformational changes required for coreceptor binding and membrane fusion. The V3 glycan supersite, comprising the V3 loop base and surrounding high mannose glycans, provides another major target [13, 14]. Antibodies including PGT121 and 10-1074 bind the N332 glycan and adjacent protein epitopes, achieving potent neutralization through steric hindrance of coreceptor interactions and envelope conformational flexibility restriction.

The membrane proximal external region of gp41 constitutes a linear epitope immediately external to the viral membrane, targeted by antibodies such as 10E8 and 4E10. This hydrophobic region undergoes transient exposure during membrane fusion, and antibodies binding this site can prevent fusion pore formation. However, the membrane proximal location and transient accessibility present challenges for antibody access. The gp120 gp41 interface represents an additional vulnerability, with antibodies such as 35O22 recognizing quaternary epitopes spanning both subunits [14]. These antibodies disrupt trimer integrity and prevent the coordinated conformational changes necessary for fusion. Beyond direct neutralization through entry inhibition, broadly neutralizing antibodies mediate Fc dependent effector functions including antibody dependent cellular cytotoxicity, antibody dependent cellular phagocytosis, and complement dependent cytotoxicity, potentially enhancing antiviral efficacy through elimination of infected cells expressing envelope proteins on their surface.

Antibody Engineering and Optimization Strategies

Advancing broadly neutralizing antibodies from naturally occurring immunoglobulins to optimized therapeutic agents requires sophisticated bioengineering approaches addressing pharmacokinetic properties, manufacturing feasibility, and functional enhancement. Fc region modifications constitute a primary optimization strategy, with amino acid substitutions such as the M428L and N434S mutations prolonging serum half-life through enhanced neonatal Fc receptor binding affinity [15]. These modifications enable antibody recycling after endocytosis, reducing lysosomal degradation and extending circulating half-lives from typical immunoglobulin G1 values of three weeks to over two months. Extended half-lives translate directly to reduced dosing frequency, improving convenience and adherence while decreasing healthcare system burden. Additional Fc engineering approaches modulate effector functions, with modifications enhancing antibody dependent cellular cytotoxicity through increased affinity for activating Fc gamma receptors, potentially augmenting clearance of infected cells and latently infected reservoir populations.

Bispecific antibody formats represent an innovative engineering strategy combining two distinct broadly neutralizing specificities within a single molecule, achieving enhanced potency and breadth while mitigating viral escape risk [16]. Molecules such as 10E8.4/iMab simultaneously target the membrane proximal external region and CD4 binding site [17], providing complementary neutralization mechanisms and requiring coincident

resistance mutations for viral escape, a substantially higher genetic barrier than single antibody approaches. Trispecific formats incorporating three distinct specificities further enhance these properties, though manufacturing complexity increases proportionally [18]. Alternative scaffolds including bispecific T cell engagers linking HIV envelope binding domains with CD3 binding domains redirect cytotoxic T lymphocytes to eliminate envelope expressing cells, offering potential for reservoir reduction beyond direct viral neutralization [19].

Production optimization addresses the substantial manufacturing challenges inherent to complex recombinant antibodies. Traditional mammalian cell expression systems, while providing appropriate post translational modifications including glycosylation patterns affecting effector functions, present scalability and cost limitations [20]. Alternative platforms including plant based expression systems and yeast production offer economic advantages, though glycosylation pattern differences require careful evaluation regarding functional consequences. Antibody humanization through framework region optimization reduces potential immunogenicity while maintaining complementarity determining region structure and binding affinity. Stability enhancements through rational design or directed evolution improve shelf life and enable formulations suitable for resource limited settings lacking cold chain infrastructure. Subcutaneous formulation development, incorporating hyaluronidase or high concentration formulations, provides administration route alternatives to intravenous infusion, improving accessibility and acceptability.

Clinical Efficacy in Prevention Applications

Passive immunization with broadly neutralizing antibodies for HIV prevention has advanced from preclinical proof of concept studies to human clinical trials, providing valuable insights regarding protective efficacy and implementation considerations. Nonhuman primate challenge studies established foundational evidence, demonstrating that systemically administered broadly neutralizing antibodies prevent viral acquisition following intravenous, vaginal, or rectal challenge with simian human immunodeficiency virus [21]. Protection correlates with serum antibody concentrations at time of challenge, with neutralization sensitive viral strains requiring lower antibody levels for prevention than resistant strains. These studies identified a neutralization potency threshold concept, wherein circulating antibody concentrations exceeding levels required for 80 percent neutralization of challenge virus in vitro provide reliable protection, offering a rational framework for dose selection in human studies.

Human prevention trials have evaluated both intravenous and subcutaneous administration of broadly neutralizing antibodies in populations at elevated HIV acquisition risk. The Antibody Mediated Prevention trials assessed VRC01 administered intravenously every eight weeks to men who have sex with men and transgender individuals in the Americas, and heterosexual women in sub Saharan Africa [22]. Results revealed statistically significant prevention efficacy against viral strains sensitive to VRC01 neutralization, with approximately 75 percent efficacy against susceptible viruses, while no protection occurred against resistant strains. This strain specific efficacy validates the neutralization potency threshold concept established in primate models and highlights the critical importance of antibody breadth and potency. Breakthrough infections occurred exclusively with viruses exhibiting in vitro resistance to VRC01, demonstrating that viral envelope sequence diversity represents a substantial challenge for single antibody prevention approaches.

Long acting formulations and antibody combinations address limitations observed in monotherapy prevention trials. Subcutaneous administration using higher concentration formulations and Fc engineered variants with extended half lives enables convenient outpatient dosing potentially acceptable for large scale prevention programs [23]. Combination approaches employing two or more broadly neutralizing antibodies targeting distinct epitopes substantially increase coverage of circulating viral strains while raising the genetic barrier to resistance, as viral escape requires simultaneous mutations affecting multiple conserved envelope regions. Modeling studies suggest that combinations targeting complementary epitope vulnerabilities could provide protection against over 99 percent of global viral diversity. However, cost considerations become multiplicative with combination approaches, and manufacturing scalability for multiple antibody products requires resolution before population level implementation.

Clinical Efficacy in Treatment Applications

Therapeutic applications of broadly neutralizing antibodies for established HIV infection encompass both antiretroviral therapy alternatives and complementary strategies aimed at viral reservoir reduction. Early phase clinical trials evaluated antibody monotherapy in viremic individuals not receiving antiretroviral therapy, providing controlled settings to assess antiviral potency and viral escape dynamics. Studies using single broadly neutralizing antibodies including 3BNC117 and 10-1074 demonstrated transient viremia reductions of 0.5 to 1.5 log10 copies per milliliter in participants harboring antibody sensitive virus, with effect duration correlating to antibody serum half-life [24]. However, viral rebound occurred in all participants, typically within 4 to 12 weeks, associated with emergence of envelope sequence variants conferring antibody resistance. Resistance mutations localized to antibody contact residues within targeted epitopes, confirming that selective pressure drove viral evolution. These findings established that monotherapy with single broadly neutralizing antibodies provides insufficient genetic barrier for durable viral suppression, analogous to early antiretroviral monotherapy experience.

Combination approaches employing two broadly neutralizing antibodies targeting non overlapping epitopes substantially improve virological outcomes. Studies administering 3BNC117 plus 10-1074 demonstrated enhanced viremia suppression magnitude and duration compared to either antibody alone, with participants maintaining viral loads below detection limits for 15 to 30 weeks in some cases. Viral rebound, when occurring, involved escape mutations affecting both antibody targets, requiring more complex genetic changes and occurring with slower kinetics. Analytical treatment interruption studies in individuals achieving viral suppression on antiretroviral therapy revealed that broadly neutralizing antibody administration prior to treatment cessation delays viral rebound compared to placebo, suggesting effects on reservoir reactivation dynamics. Mechanistic investigations indicate that Fc mediated effector functions may contribute to reservoir cell elimination, complementing direct viral neutralization.

Integration of broadly neutralizing antibodies with antiretroviral therapy represents a synergistic strategy leveraging complementary mechanisms [25]. Combination studies demonstrate additive or synergistic virological suppression, with antibodies providing immune mediated viral clearance while antiretrovirals prevent new infection cycles. This approach potentially enables antiretroviral therapy simplification or structured treatment interruptions while maintaining viral control. Cure research investigations explore broadly neutralizing antibodies as components of shock and kill strategies, wherein latency reversing agents reactivate proviral expression in reservoir cells while antibodies mediate elimination of reactivated cells through Fc effector functions. Preliminary studies show modest reservoir reductions, though substantial challenges remain regarding latency reversal efficacy and antibody access to tissue reservoir sites including lymphoid tissues and central nervous system.

Implementation Challenges and Economic Considerations

Translation of broadly neutralizing antibodies from clinical trials to widespread prevention and treatment implementation confronts substantial practical barriers spanning manufacturing, distribution, administration, and economic domains [26]. Production costs represent a primary constraint, with recombinant monoclonal antibody manufacturing requiring sophisticated bioreactor facilities, extensive purification processes, and rigorous quality control [27]. Current production costs for broadly neutralizing antibodies range from several thousand to over ten thousand dollars per gram, and therapeutic or prevention doses typically require 10 to 30 milligrams per kilogram body weight, translating to substantial per person costs. While economies of scale and process optimization may reduce costs, broadly neutralizing antibodies are unlikely to achieve price parity with small molecule antiretrovirals, which benefit from simpler manufacturing and generic competition.

Infrastructure requirements for administration present additional challenges, particularly in resource limited settings bearing disproportionate HIV burden [28]. Intravenous administration necessitates healthcare facility visits with trained personnel and appropriate supplies, creating logistical barriers and opportunity costs for recipients. Subcutaneous formulations partially address this limitation, potentially enabling self-administration or community based delivery, though cold chain requirements for product stability remain problematic in settings with unreliable electricity infrastructure. Dosing frequency, even with extended half-life variants requiring administration every 2 to 6 months, exceeds convenience of daily oral antiretrovirals for many individuals, though others may prefer intermittent dosing. Patient preferences regarding administration route, frequency, and setting require systematic assessment to guide implementation strategies.

Viral resistance development poses a biological barrier potentially limiting long term efficacy [29]. While combination antibody approaches substantially increase the genetic barrier compared to monotherapy, viral evolution remains possible, particularly in prevention applications where breakthrough infections introduce resistant founder viruses. Surveillance systems monitoring envelope sequence diversity in circulating viral strains and breakthrough infections must inform antibody selection and combination strategies [30]. Development of next generation antibodies targeting additional epitopes and exhibiting enhanced potency and breadth provides a pipeline addressing resistance concerns, though regulatory pathways and clinical validation timelines extend implementation horizons. Immunogenicity represents an additional consideration, as anti drug antibodies developing against administered broadly neutralizing antibodies may reduce efficacy or cause adverse reactions, though clinical experience to date reveals low immunogenicity rates. Equitable access considerations are paramount, as high costs and infrastructure requirements risk exacerbating existing disparities if broadly neutralizing antibodies become available exclusively in high income settings while remaining inaccessible to populations in low and middle income countries where HIV prevalence is highest.

CONCLUSION

Broadly neutralizing antibodies represent a significant scientific achievement and promising addition to HIV prevention and treatment armamentarium, leveraging sophisticated understanding of viral envelope structure and immune recognition to target functionally conserved epitopes. Extensive preclinical and clinical evidence demonstrates that these antibodies provide protection against viral acquisition in prevention applications and suppress viremia in treatment contexts when appropriately matched to viral envelope sequences. Antibody engineering advances including Fc modifications extending half-life, bispecific formats enhancing breadth and

potency, and manufacturing optimizations improving scalability have progressively enhanced therapeutic potential. However, substantial challenges constrain widespread implementation, including high production costs limiting accessibility, viral escape through envelope sequence variation requiring combination approaches, and infrastructure requirements for parenteral administration. The strain specific nature of protection and treatment efficacy necessitates careful viral sequence monitoring and strategic antibody selection. Evidence quality from randomized controlled trials is robust for specific antibody candidates, though generalizability across diverse populations and settings requires expanded investigation. Broadly neutralizing antibodies may find optimal utility in niche applications including prevention for individuals unable to tolerate oral pre exposure prophylaxis, treatment of multidrug resistant infections, or as components of cure strategies targeting viral reservoirs. Continued research addressing cost reduction, developing next generation antibodies with improved breadth, and designing rational combinations will determine whether broadly neutralizing antibodies transition from specialized tools to mainstream interventions accessible across global populations disproportionately affected by HIV. Prioritize development of cost-effective manufacturing platforms and subcutaneous formulations while conducting implementation science research in resource limited settings to ensure broadly neutralizing antibody benefits reach populations with greatest HIV burden.

REFERENCES

1. Alum, E.U., Ugwu, O.P.C., Obeagu, E.I., Okon, M.B.: Curtailing HIV/AIDS Spread: Impact of Religious Leaders. Newport International Journal of Research in Medical Sciences (NIJRMS), 2023; 3(2): 28-31.
2. Payagala, S., Pozniak, A.: The global burden of HIV. Clinics in Dermatology. 42, 119–127 (2024). https://doi.org/10.1016/j.clindermatol.2024.02.001
3. Singh, K., Mehta, D., Dumka, S., Chauhan, A.S., Kumar, S.: Quasispecies Nature of RNA Viruses: Lessons from the Past. Vaccines. 11, 308 (2023). https://doi.org/10.3390/vaccines11020308
4. Alum, E.U., Uti, D.E., Ugwu, O.P.-C., Alum, B.N.: Toward a cure – Advancing HIV/AIDs treatment modalities beyond antiretroviral therapy: A Review. Medicine. 103, e38768 (2024). https://doi.org/10.1097/MD.0000000000038768
5. Murin, C.D., Wilson, I.A., Ward, A.B.: Antibody responses to viral infections: a structural perspective across three different enveloped viruses. Nat Microbiol. 4, 734–747 (2019). https://doi.org/10.1038/s41564-019-0392-y
6. Moirangthem, R., Bar-On, Y.: Passive Immunization in the Prevention and Treatment of Viral Infections. European Journal of Immunology. 55, e202451606 (2025). https://doi.org/10.1002/eji.202451606
7. Burton, D.R., Mascola, J.R.: Antibody responses to envelope glycoproteins in HIV-1 infection. Nat Immunol. 16, 571–576 (2015). https://doi.org/10.1038/ni.3158
8. Mahomed, S.: Broadly neutralizing antibodies for HIV prevention: a comprehensive review and future perspectives. Clinical Microbiology Reviews. 37, e00152-22 (2024). https://doi.org/10.1128/cmr.00152-22
9. Klasse, P.J., Sanders, R.W., Ward, A.B., Wilson, I.A., Moore, J.P.: The HIV-1 envelope glycoprotein: structure, function and interactions with neutralizing antibodies. Nat Rev Microbiol. 23, 734–752 (2025). https://doi.org/10.1038/s41579-025-01206-6
10. Wensel, D., Sun, Y., Li, Z., Zhang, S., Picarillo, C., McDonagh, T., Fabrizio, D., Cockett, M., Krystal, M., Davis, J.: Discovery and Characterization of a Novel CD4-Binding Adnectin with Potent Anti-HIV Activity. Antimicrobial Agents and Chemotherapy. 61, 10.1128/aac.00508-17 (2017). https://doi.org/10.1128/aac.00508-17
11. Srinivasan, S., Ghosh, M., Maity, S., Varadarajan, R.: Broadly neutralizing antibodies for therapy of viral infections. Antibody Technology Journal. 6, 1–15 (2016). https://doi.org/10.2147/ANTI.S92190
12. Cale, E.M., Gorman, J., Radakovich, N.A., Crooks, E.T., Osawa, K., Tong, T., Li, J., Nagarajan, R., Ozorowski, G., Ambrozak, D.R., Asokan, M., Bailer, R.T., Bennici, A.K., Chen, X., Doria-Rose, N.A., Druz, A., Feng, Y., Joyce, M.G., Louder, M.K., O'Dell, S., Oliver, C., Pancera, M., Connors, M., Hope, T.J., Kepler, T.B., Wyatt, R.T., Ward, A.B., Georgiev, I.S., Kwong, P.D., Mascola, J.R., Binley, J.M.: Virus-like Particles Identify an HIV V1V2 Apex-Binding Neutralizing Antibody that Lacks a Protruding Loop. Immunity. 46, 777-791.e10 (2017). https://doi.org/10.1016/j.immuni.2017.04.011
13. Arandhara, M., Kumar, Y., Dixit, N.M., Maiti, P.K.: Clade-Specific Influences of Glycans on the Interactions between HIV-1 Envelope and Broadly Neutralizing Antibodies. J. Chem. Inf. Model. (2025). https://doi.org/10.1021/acs.jcim.5c01051
14. Longo, N.S., Sutton, M.S., Shiakolas, A.R., Guenaga, J., Jarosinski, M.C., Georgiev, I.S., McKee, K., Bailer, R.T., Louder, M.K., O'Dell, S., Connors, M., Wyatt, R.T., Mascola, J.R., Doria-Rose, N.A.: Multiple Antibody Lineages in One Donor Target the Glycan-V3 Supersite of the HIV-1 Envelope Glycoprotein and Display a Preference for Quaternary Binding. Journal of Virology. 90, 10574–10586 (2016). https://doi.org/10.1128/jvi.01012-16

15. Mackness, B.C., Jaworski, J.A., Boudanova, E., Park, A., Valente, D., Mauriac, C., Pasquier, O., Schmidt, T., Kabiri, M., Kandira, A., Radošević, K., Qiu, H.: Antibody Fc engineering for enhanced neonatal Fc receptor binding and prolonged circulation half-life. mAbs. 11, 1276–1288 (2019). https://doi.org/10.1080/19420862.2019.1633883
16. Nie, S., Wang, Z., Moscoso-Castro, M., D'Souza, P., Lei, C., Xu, J., Gu, J.: Biology drives the discovery of bispecific antibodies as innovative therapeutics. Antibody Ther. 3, 18–62 (2020). https://doi.org/10.1093/abt/tbaa003
17. Nordstrom, J.L., Ferrari, G., Margolis, D.M.: Bispecific antibody-derived molecules to target persistent HIV infection. J Virus Erad. 8, 100083 (2022). https://doi.org/10.1016/j.jve.2022.100083
18. Wu, X., Demarest, S.J.: Building blocks for bispecific and trispecific antibodies. Methods. 154, 3–9 (2019). https://doi.org/10.1016/j.ymeth.2018.08.010
19. Board, N.L.: DESIGN AND DEVELOPMENT OF BISPECIFIC ANTIBODIES FOR HIV-1 RESERVOIR ELIMINATION, http://jhir.library.jhu.edu/handle/1774.2/68805, (2023)
20. Mark, J.K.K., Lim, C.S.Y., Nordin, F., Tye, G.J.: Expression of mammalian proteins for diagnostics and therapeutics: a review. Mol Biol Rep. 49, 10593–10608 (2022). https://doi.org/10.1007/s11033-022-07651-3
21. Saunders, K.O., Pegu, A., Georgiev, I.S., Zeng, M., Joyce, M.G., Yang, Z.-Y., Ko, S.-Y., Chen, X., Schmidt, S.D., Haase, A.T., Todd, J.-P., Bao, S., Kwong, P.D., Rao, S.S., Mascola, J.R., Nabel, G.J.: Sustained Delivery of a Broadly Neutralizing Antibody in Nonhuman Primates Confers Long-Term Protection against Simian/Human Immunodeficiency Virus Infection. Journal of Virology. 89, 5895–5903 (2015). https://doi.org/10.1128/jvi.00210-15
22. Mgodi, N.M., Takuva, S., Edupuganti, S., Karuna, S., Andrew, P., Lazarus, E., Garnett, P., Shava, E., Mukwekwerere, P.G., Kochar, N., Marshall, K., Rudnicki, E., Juraska, M., Anderson, M., Karg, C., Tindale, I., Greene, E., Luthuli, N., Baepanye, K., Hural, J., Gomez Lorenzo, M.M., Burns, D., Miner, M.D., Ledgerwood, J., Mascola, J.R., Donnell, D., Cohen, M.S., Corey, L., Team, the H. 703/HPTN 081: A Phase 2b Study to Evaluate the Safety and Efficacy of VRC01 Broadly Neutralizing Monoclonal Antibody in Reducing Acquisition of HIV-1 Infection in Women in Sub-Saharan Africa: Baseline Findings. JAIDS Journal of Acquired Immune Deficiency Syndromes. 87, 680 (2021). https://doi.org/10.1097/QAI.0000000000002649
23. Desai, M., Kundu, A., Hageman, M., Lou, H., Boisvert, D.: Monoclonal antibody and protein therapeutic formulations for subcutaneous delivery: high-concentration, low-volume vs. low-concentration, high-volume. mAbs. 15, 2285277 (2023). https://doi.org/10.1080/19420862.2023.2285277
24. Cohen, Y.Z., Butler, A.L., Millard, K., Witmer-Pack, M., Levin, R., Unson-O'Brien, C., Patel, R., Shimeliovich, I., Lorenzi, J.C.C., Horowitz, J., Walsh, S.R., Lin, S., Weiner, J.A., Tse, A., Sato, A., Bennett, C., Mayer, B., Seaton, K.E., Yates, N.L., Baden, L.R., deCamp, A.C., Ackerman, M.E., Seaman, M.S., Tomaras, G.D., Nussenzweig, M.C., Caskey, M.: Safety, pharmacokinetics, and immunogenicity of the combination of the broadly neutralizing anti-HIV-1 antibodies 3BNC117 and 10-1074 in healthy adults: A randomized, phase 1 study. PLOS ONE. 14, e0219142 (2019). https://doi.org/10.1371/journal.pone.0219142
25. Schwarzer, R., Gramatica, A., Greene, W.C.: Reduce and Control: A Combinatorial Strategy for Achieving Sustained HIV Remissions in the Absence of Antiretroviral Therapy. Viruses. 12, 188 (2020). https://doi.org/10.3390/v12020188
26. Gieber, L., Muturi-Kioi, V., Malhotra, S., Sitlani, A.: Clinical and Regulatory Challenges and Opportunities for Monoclonal Antibodies in Low- and Middle-Income Countries: Lessons from COVID-19 and Beyond. Pharm Med. 37, 203–214 (2023). https://doi.org/10.1007/s40290-023-00473-z
27. Madu, C.V., Aloh, H.E., Ugwu, O.P.C., Obeagu, E.I., Uti, D.E., Egba, S.I., Ukaidi, C.U.A.: The price of progress: Assessing the financial costs of HIV/AIDS management in East Africa. Medicine (Baltimore). 104, e42300 (2025). https://doi.org/10.1097/MD.0000000000042300
28. Ezenwaji, C.O., Alum, E.U., Ugwu, O.P.-C.: Bridging the gap: telemedicine as a solution for HIV care inequities in rural and vulnerable communities. International Journal for Equity in Health. 24, 205 (2025). https://doi.org/10.1186/s12939-025-02584-2
29. Laughlin, C., Schleif, A., Heilman, C.A.: Addressing Viral Resistance Through Vaccines. Future Virology. 10, 1011–1022 (2015). https://doi.org/10.2217/fvl.15.53
30. Lakshmanan, K., Liu, B.M.: Impact of Point-of-Care Testing on Diagnosis, Treatment, and Surveillance of Vaccine-Preventable Viral Infections. Diagnostics. 15, 123 (2025). https://doi.org/10.3390/diagnostics15020123

CITE AS: Nyakairu Doreen G. (2026). Broadly Neutralizing Antibodies for HIV Prevention and Treatment: Advances and Challenges. IDOSR JOURNAL OF BIOLOGY, CHEMISTRY AND PHARMACY 11(1):93-98. https://doi.org/10.59298/IDOSR/JBCP/26/102.9398