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Towards eradicating HIV: Cutting-edge strategies for treatment and prevention

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Abstract. HIV causes a serious infectious disease called AIDS, which has a serious impact on human health and social stability, and many celebrities have even been diagnosed with the disease. There is no cure for HIV-induced AIDS, but antiretroviral therapy can, to a certain extent, strengthen the immune system and help the body fight off other diseases. However, more exploration is still needed. This paper analyses several relatively novel treatment options, preventive measures and public health strategies, and proposes some possible breakthroughs to solve the HIV problem as well as directions for future efforts. Firstly, it briefly describes the pathways and effects of HIV infection, and clarifies the mode of transmission and the importance of HIV. It then describes traditional treatment modalities and innovative treatment options, and presents future perspectives. It concludes with an overview of preventive measures and public health strategies for HIV. Standing on the shoulders of those who have gone before, a cure for HIV seems to be getting closer. It is hoped that the review in this article will give readers a deeper understanding of HIV-related treatment and prevention in the last three years or even the last year, and contribute to the ultimate cure of HIV.

Keywords: HIV, treatment, prevention.

1. Introduction

Human Immunodeficiency Virus, a serious virus that causes Acquired Immunodeficiency Syndrome, is a viral widespread worldwide and has created a major global public health problem. Since its discovery in 1981, HIV has caused millions of deaths and a degree of social panic. Scientific researchers have not suspended their research on HIV, and have achieved considerable results, but the current situation is still serious, and should not be taken lightly.

HIV research has advanced remarkably during the last few decades. Grinspoon SK et al. discovered that, after a median follow-up of 5.1 years, individuals with HIV infection who took pitavastatin had a decreased risk of a significant adverse cardiovascular event compared to those who got a placebo [1]. Tanaka K et al. also discovered that the degree of HIV transcriptional activity on antiretroviral therapy (ART) is influenced by the HIV integration site, T cell differentiation status, anatomical location, and extrinsic factors like gender, time, and stress. Innovative methods that integrate immune augmentation with latency reversal exhibit potential in animal models [2]. In terms of prevention, the initial successes in Africa are a good model example. Sustained political commitment, multisectoral collaboration and investment in prevention are critical to realizing the vision of an AIDS-free generation in Africa and

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beyond [3]. The development and assessment of HIV prevention strategies utilizing AI and machine learning may profit from the application of scientific methods, such as qualitative end-user assessments, and should be developed and assessed with an emphasis on equity issues. AI and machine learning techniques can also be used to prevent HIV [4].

The significance of this study is to provide insights into innovative treatment and prevention strategies against HIV to address the current challenges faced. As a serious global public health problem, HIV affects the lives and socio-economic development of millions of people. By researching novel treatments and innovative preventive measures, it can provide an important scientific basis for improving the survival rate and quality of life of HIV-infected patients. The exploration of the prospects for the application of new technologies in AIDS management will help to expand new ideas for treatment and prevention and contribute to the realization of global HIV prevention and treatment goals.

2. Pathways and impact of HIV infection

2.1. HIV transmission pathways and biological mechanisms

HIV is transmitted in various ways, including blood, sexual contact, mother-to-child transmission, and shared injection equipment. Sexual transmission occurs when HIV comes into contact with the mucous membranes of the genital tract during sexual intercourse. Blood transmission includes exposure through blood transfusions, injection drug use, and accidental exposure in healthcare settings. Mother-to-child transmission occurs during pregnancy, childbirth, and breastfeeding. Furthermore, sharing injection equipment represents a significant risk for HIV transmission [5].

HIV infection occurs when the virus interacts with host cells. HIV is a retrovirus with a life cycle that includes binding of viral particles to host cell membranes, transcription of viral RNA into DNA, integration of viral DNA into the host cell chromosome, expression of viral genes and synthesis of proteins, assembly of new viral particles, and release of virions. Disrupting the virus life cycle or enhancing host immune responses is the most effective way to control HIV infection and replication.

2.2. Impact of HIV infection on individuals and society

Depending on the stage of infection, different HIV signs and symptoms exist. The disease spreads more easily in the first few months after infection, although most people don't realize they have it until much later. It can take a few weeks for someone to exhibit symptoms following an infection. Some people might be experiencing flu-like symptoms, like fever, headaches, rashes, and sore throats. The infection gradually weakens the immune system. Additional signs and symptoms that could arise from this include fever, diarrhea, coughing, swollen lymph nodes, and weight loss. If HIV-positive people do not receive treatment, they may also develop life-threatening diseases such as tuberculosis (TB), cryptococcal meningitis, severe bacterial infections, and malignancies such lymphomas and Kaposi's sarcoma. HIV makes certain diseases worse, such as mpox, hepatitis B, and hepatitis C [1].

HIV infection is not only a health problem; it also has a certain degree of impact on society. As AIDS continues to spread, society will face a series of difficulties. Firstly, the epidemic endangers the health and stability of society. The demand for medical resources will increase because of the increase in the number of AIDS patients, leading to problems such as overworked health care system and uneven distribution of resources. Secondly, people living with HIV and their families will face psychological and emotional challenges. Social prejudice and stigmatisation of AIDS will add to the psychological burden of the patients, causing them and their families to experience social exclusion, loneliness and even alienation from friends and relatives. Most importantly, the huge cost of care and the lifelong medication regimen may drive many families into poverty and even bankruptcy, which is a violent shock to society. HIV has a great impact on both personal health and social harmony, so its prevention and treatment need to be paid attention by the whole society and is an important issue to research.

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3. Treatment strategies for HIV

3.1. Conventional treatment strategies

There is currently no treatment for HIV infection. In the last few decades, there has been a significant advancement in the treatment of HIV. Complex regimens including high toxicity, many daily doses, and insufficient viral suppression have been replaced by more straightforward, highly successful daily oral regimens [2]. Antiretroviral medications are used to treat it, preventing the virus from multiplying within the body. While the most popular and conventional form of ART does not cure HIV infection, it can boost immunity and help the body fight off other illnesses. Retroviral therapy lowers a patient's body's viral load. People can live long and healthy lives after this, as it can end symptoms. HIV cannot be transmitted to a partner through sexual activity by someone on antiretroviral therapy and showing no signs of the virus in their blood. Unfortunately, though, this treatment needs to be continued forever [1].

Women living with HIV should begin antiretroviral medication as soon as feasible. By doing this, the danger of HIV transmission to the fetus or the newborn through breast milk is decreased and the mother's health is protected. Antiretroviral drugs can also stave against HIV in non-HIV individuals. The medication is referred to as pre-exposure prophylaxis (PrEP) when used before possible HIV exposure and post-exposure prophylaxis (PEP) when taken after possible HIV exposure. People who are at high risk of HIV infection can utilize PrEP or PEP; however, they should first consult with their practitioner [1].

3.2. Innovative treatment options in recent years

3.2.1. Long-acting (LA) injectable antiretroviral therapy. Patients can select the kind of treatment they desire because LA injectable antiretroviral therapies are now available as an alternative to daily antiretroviral treatments. LA injectable ARV formulations have the potential to enhance community health outcomes by lowering HIV transmission while also improving individual health by removing obstacles to daily prescription adherence [6].

3.2.2. Two-drug regimens for the treatment. HIV therapy regimens consisting of two drugs are becoming more widely accessible. While most national guidelines advocate the oral regimen of dolutegravir with lamivudine as the best option, it is not currently included in WHO HIV treatment guidelines and is not commonly used in Africa. In the USA, Europe, and Australia, long-acting injectable cabotegravir and rilpivirine are being introduced; however, their usage in sub-Saharan Africa is still limited to clinical trials. The adoption of two-drug regimens may be advantageous given the rising incidence of non-communicable diseases, longer life expectancies, and polypharmacy among HIV-positive individuals. This is especially true for African women, adolescents, and older adults. This point of view examines the available data and identifies the main knowledge gaps, advantages, and hazards associated with the use of two-drug regimens in African public health settings. Researchers propose that, once chronic hepatitis B has been ruled out, virologically suppressed people utilizing the public health strategy may safely switch to a two-drug regimen of dolutegravir and lamivudine. When on two-drug regimens, individuals with HIV should complete a course of hepatitis B immunizations. In the sub-Saharan African public health system, further proof of efficacy is needed to support the use of long-acting cabotegravir and rilpivirine, as well as the combination of dolutegravir and lamivudine in the test-and-treat paradigm [7].

3.2.3. Risk of cardiovascular disease (CVD) during HIV treatment in patients. Considering people with HIV have a higher risk of CVD, this community needs to know about primary preventative measures. Participants with HIV infection who took pitavastatin had a lower risk of a severe adverse cardiovascular event throughout a median follow-up of 5.1 years when compared to those who received a placebo [1].

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3.3. Future perspectives on treatment

Researchers can build on existing antiretroviral drugs to develop more targeted and effective antiretroviral drugs that reduce treatment side effects while improving efficacy.

Immunotherapy may also be a future therapeutic focus, with the activation or enhancement of a patient's own immune response to inhibit viral replication and progression. A vaccine against AIDS has yet to be developed, and immunotherapy may be possible through the development of a vaccine. Antibody therapy and the use of immune enhancers are also promising.

The treatment of specific HIV-induced diseases, such as Pitavastatin's Impact on CVD in HIV mentioned above, is also a good approach. It can also be used to specifically treat HIV-induced diseases such as Candida pneumonia and tuberculosis.

4. HIV prevention measures and public health strategies

4.1. Traditional prevention measures

Firstly, safe sex including the proper use of male or female condoms and controlling the number of sexual partners, is able to control the transmission of HIV through sexual contact. Secondly, avoidance of sharing of injecting equipment, including abstinence from drug abuse and provision of sterile needles to prevent blood transmission of HIV. Thirdly, prevention of mother-to-child transmission, including the provision of antiretroviral treatment for HIV-positive pregnant women, the use of safe delivery measures such as caesarean sections and, resources permitting, the use of infant formulas in lieu of breastfeeding to reduce the risk of HIV transmission during breastfeeding.

4.2. Innovative prevention measures in recent years

4.2.1. Biomedical interventions. Using scientific innovation to supplement conventional preventive methods and lessen the epidemic's burden, Africa has been in the forefront of implementing biological therapies to prevent HIV transmission. PrEP, voluntary medical male circumcision (VMMC), HIV vaccine development, and other biomedical therapies present viable paths toward reducing HIV infection and advancing public health throughout the continent. PrEP is a cutting-edge HIV prevention program that reduces a person's risk of HIV infection by giving them a daily oral pill containing antiretroviral medication. In Africa, PrEP has been applied in a variety of settings, including high-risk populations including serodiscordant couples, sex workers, and men who have sex with men (MSM). By providing PrEP to those who are more likely to come into touch with the virus, Africa expects to limit the virus's transmission and significantly reduce the number of new infections [3].

4.2.2. The implementation of telemedicine. The swift implementation of telemedicine has enabled Open Door Health to continue delivering HIV and LGBTQ+ care during the COVID-19 outbreak. When access to clinical services is limited, patients value consistency in their care, especially when it comes to HIV prevention and treatment. High levels of satisfaction with telemedicine are reported by both patients and physicians, and most barriers to clinical service delivery may be addressed by providers. if payers maintain reimbursement parity when the COVID-19 crisis ends may affect if telemedicine for HIV services is maintained [8].

4.2.3. Capitalizing on aspirations of adolescent girls and young women. Adolescent girls and young women account for 26% of new HIV infections in Southern and Eastern Africa; these populations are 2.5 times more likely to contract HIV than males. Because there is a limited window of opportunity for aspiration for adolescent girls and young women, interventions should prioritize SRH education and the promotion of an alternative vision of adolescent motherhood by encouraging girls to complete their education, obtain employment, and take advantage of other opportunities to generate income while also taking into account the needs of girls who are in and out of school [9].

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4.3. Development and prospects of public health strategies

The goal of lowering the HIV infection rate among MSM in Mozambique can be achieved by stepping up public health measures to prevent and treat HIV infection. Reaching this objective calls for a concentrated effort to interact with MSM groups, providing information and services tailored to their individual need and addressing the range of vulnerabilities they might encounter. We can only effectively handle the complexity of HIV prevention and care among MSM by using such focused and compassionate approaches, which will eventually promote a more just and healthy society [10]. The Department of Health and Human Services (HHS) is constantly looking for fresh approaches to problems. Collaborations with civil society will be key to the development of many of these solutions. For instance, the pharmaceutical company has agreed to give PrEP medication for up to 200 000 persons annually for a maximum of 11 years following HHS conversations with Gilead Sciences, Inc. The government has consented to pay for the expenses related to drug distribution [11]. Public health strategies for the prevention and control of AIDS are promising. First, advanced technologies, such as digital health tools and artificial intelligence, can be integrated, which can enhance patient surveillance and optimize intervention programs for patients. Secondly, comprehensive sex education and community outreach can reduce stigma and also help some people to understand the harm caused by AIDS. At the same time, mother-to-child transmission can be eliminated through universal screening and related policies. Finally, AIDS can be effectively prevented through global cooperation on comprehensive prevention strategies that integrate biomedical, behavioral and structural interventions.

5. Conclusion

This paper reviews the current stage of innovative research progress on HIV and provides an outlook on future treatments and public health tools, starting from the pathways and effects of HIV infection, HIV treatment options, HIV prevention measures and public health strategies. With the accumulation of experience of the predecessors, the later researchers stand on the shoulders of the predecessors and advance the human understanding of HIV step by step. Existing research is becoming more innovative in HIV treatment options, improving preventive measures by incorporating previous experiences, and improving public health strategies. The review in this paper can be used as a reference for researchers to help them gain a clear understanding of the traditional view of HIV as well as to learn about several newer treatments and prevention and public health strategies that can help researchers in their subsequent studies. However, the articles reviewed in this article are limited and further systematic analysis is needed. As research continues, more public health measures will be popularized, and relevant vaccines and treatments will be developed.

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