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A Review on HIV/AIDS Treatment and Prevention.

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ABSTRACT:

Still major global health issues are the human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS). Especially in low- and middle-income nations, HIV still poses a significant threat even with significant knowledge of and ability to treat the virus. By turning the deadly virus into a controllable chronic condition, antiretroviral therapy (ART) has greatly changed HIV treatment. Strategies for prevention such as condom use, harm reduction initiatives, post-exposure prophylaxis (PEP), and pre-exposure prophylaxis (PrEP) have greatly reduced the frequency of new infections. Yet, issues including stigma, treatment access, drug resistance, and unequal distribution of medical care persist. This paper looks at current treatment and prevention strategies, highlights new research and future directions in the fight against HIV/AIDS, and discusses continuing challenges.

Keywords:
HIV, AIDS, Antiretroviral Therapy (ART), Pre-exposure Prophylaxis (PrEP), Post-exposure Prophylaxis (PEP), HIV Vaccine, Treatment Adherence, HIV Prevention, Drug Resistance, Gene Therapy.

Introduction

The response of the world to the pandemic has changed dramatically since the early 1980s, when the Human Immunodeficiency Virus (HIV) was found. HIV compromises the body's defenses, particularly the CD4+ T cells, which are essential for immunological function. Untreated HIV can cause Acquired Immunodeficiency Syndrome (AIDS), characterized by significant immunosuppression, an increased risk of infections, and malignancies. The epidemic has claimed more than 36 million lives so far; by 2023, about 38 million people globally were projected to be HIV positive (UNAIDS, 2023). Though ART has significantly improved the prognosis for those with HIV, the virus still has no certain cure and its spread remains a major public health concern.

Pathogenesis of HIV

The retrovirus HIV mostly affects CD4+ T cells, which are essential for the reaction of the immune system to infections. By binding to the CD4 receptor and a co-receptor—either CCR5 or CXCR4—on the T cell's surface, the viral envelope protein gp120 helps the virus enter the host cell. Inside, the viral enzyme reverse transcriptase converts the RNA into DNA; integrase then adds the RNA to the host's genome. This mechanism lets the virus replicate and produce fresh viral particles, which are then released into the circulation. .

As the virus multiplies, less CD4+ T cells are produced, therefore weakening the immune system. HIV infection's clinical course reveals three separate stages: :

1. **Acute HIV infection:** Marked by a flu-like illness and intense viral replication, the first stage lasts two to four weeks following exposure.
2. **Chronic HIV infection**: The virus multiplies and CD4+ T cell counts gradually drop without ART.
3. **AIDS:** AIDS is the last stage, when opportunistic infections and malignancies are caused by a very weakened immune system.

HIV to AIDS progresses over several years without ART; those without access to adequate treatment, however, see this time frame shortened.

HIV Treatment: Antiretroviral Therapy (ART)

The primary treatment for HIV infection is antiretroviral therapy (ART). Antiretroviral therapy (ART) combines at least three antiretroviral medications from different classes to lower the viral load, stop HIV replication, and maintain immune function. ART can greatly lower the risk of HIV transmission and help HIV patients to live longer, healthier lives by lowering the viral load to undetectable levels when taken consistently.

Classes of Antiretroviral Drugs

1. 1.**The reverse transcriptase enzyme**, Blocking the reverse transcriptase enzyme, which is required for HIV replication, nucleoside reverse transcriptase inhibitors (NRTIs) Common ones are tenofovir, emtricitabine, zidovudine, and lamivudine.

2. **Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs):** Non-nucleoside reverse transcriptase inhibitors (NNRTIs) stop HIV RNA from being converted to DNA by binding to the active site of reverse transcriptase. Among the medications in this group are nevirapine, rilpivirine, and efavirenz.

3. **Protease Inhibitors (PIs)**: These medications block the enzyme protease, which HIV virions need to grow. Among PIs are lopinavir and darunavir. .

4. **Inhibitors of Integrase Strand Transfer (INSTIs):** Inhibitors of Integrase Strand Transfer (INSTIs): By blocking the enzyme integrase from facilitating integration of HIV's genetic material into the host genome, INSTIs Among the notable INSTIs are dolutegravir, bictegravir, and raltegravir.

5. **Pharmacokinetic Enhancers (Boosters):**Including cobicistat and ritonavir, pharmacokinetic enhancers (boosters) are medications that reduce the metabolism of other antiretroviral drugs to increase their efficacy and preserve higher blood concentrations of the drugs.

First-Line ART Regimens

Current WHO and U.S. Department of Health and Human Services (HHS) guidelines call for first-line regimens consisting of NRTIs and INSTIs used in combination. For instance, a typical course is dolutegravir combined with tenofovir disoproxil fumarate (TDF) and emtricitabine (FTC). They are effective, well-tolerated, and have little chance of side effects.

Adherence to ART

Viral suppression is best achieved by ART compliance. Noncompliance might result in treatment failure, disease progression, and drug resistance. The complexity of the program, adverse effects, mental health concerns, and financial limitations all influence compliance in various ways. Reducing the frequency of drug administration helps long-acting ART formulations like cabotegravir and rilpivirine to improve adherence. .

HIV Prevention Strategies

The primary way to stop the HIV/AIDS epidemic is to prevent new HIV infections. Many of the successful transmission-reduction techniques are preventive.

Pre-Exposure Prophylaxis (PrEP)

PrEP is the application of antiretroviral drugs to prevent HIV infection in high-risk individuals. Used regularly, the daily mix of emtricitabine (FTC) and tenofovir disoproxil fumarate (TDF) has been proven to reduce the risk of HIV infection by more than ninety percent (Grant et al., 2010). PrEP has been particularly effective for men who have sex with men (MSM), heterosexuals at high risk, and those who inject drugs.

Post-Exposure Prophylaxis (PEP)

Started within 72 hours of possible HIV exposure—such as via unprotected sex or needle sharing—PEP is a short-term course of ART. Started quickly, PEP can reduce the likelihood of HIV infection if taken for twenty-eight days.

Prevention of Mother-to-Child Transmission (PMTCT)

PMTCT aims to lower the probability that an HIV-positive mother would pass on her child during pregnancy, delivery, or nursing. Achieving this will be helped by giving the mother ART during her pregnancy, delivery, and lactation as well as giving the baby ART following birth. PMTCT has especially lowered mother-to-child transmission rates in low-resource areas (Mofenson et al., 2017).

Condom Use and Safe Sexual Practices

Condoms remain one of the most effective means to prevent HIV transmission during sexual activity. Plans for HIV prevention still include condom use as a key component along with safe sex education.

Needle Exchange Programs

Needlestick exchange programs are a crucial harm reduction tool for drug injectors. These projects greatly lower the possibility of HIV transmission by sharing tainted needles by offering clean syringes and needles (Wodak & Cooney, 2006).

Challenges in HIV Treatment and Prevention

Despite significant progress, several challenges remain in the fight against HIV/AIDS:
1.Stigma and Discrimination: Needlestick exchange programs are a crucial harm reduction tool for drug injectors. These projects greatly lower the possibility of HIV transmission by sharing tainted needles by offering clean syringes and needles (Wodak & Cooney, 2006).

2. Access to Healthcare:In low- and middle-income nations, infrastructure deficiencies, lack of medical professionals, and budgetary constraints limit access to ART and preventive services (Suthar et al., 2014).

3.Drug Resistance: In low- and middle-income nations, infrastructure deficiencies, lack of medical professionals, and budgetary constraints limit access to ART and preventive services (Suthar et al., 2014).

4. **Emerging Infections and Comorbidities**: HIV-positive people are more prone to have comorbid conditions like specific cancers, hepatitis, and tuberculosis. Treating HIV means challenging co-infection control (Shao et al., 2019).

Future Directions

The future of HIV treatment and prevention holds promise with the advent of new technologies and strategies:
1. HIV Vaccines: Because the virus may change quickly, it has been difficult to build an effective vaccine. Nevertheless, current studies are investigating cutting-edge strategies, such as mRNA vaccines, which have demonstrated promise in recent trials (Barouch et al., 2020).
2. Gene Therapy and CRISPR: By altering the host's DNA to make it resistant to HIV infection, advances in gene-editing technologies like CRISPR are investigating possible solutions (Hare et al., 2016).
3. Long-Acting Injectable ART: Botegravir and rilpivirine are two injectable ART formulations that may allow for less frequent dosage, which could enhance treatment results and adherence for HIV patients (Orkin et al., 2020).

Conclusion

Although HIV/AIDS is still a major worldwide health concern, improvements in prevention and treatment have made the illness more controllable. The disease's burden has been considerably decreased by ART, PrEP, and harm reduction techniques. But issues including stigma, healthcare access, medication resistance, and new co-infections still impede advancement. A comprehensive strategy will be required to stop the HIV/AIDS epidemic, but there is hope for the future thanks to ongoing research into vaccines, long-acting medicines, and gene therapies.

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