THE EFFECT OF ANTIRETROVIRAL THERAPY ON THE COURSE OF HIV INFECTION

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Abstract. Human immunodeficiency virus (HIV) infection remains a significant global public health challenge. The introduction of combined antiretroviral therapy (ART) has fundamentally changed the natural course of the disease, transforming it from a rapidly progressive and frequently fatal condition into a manageable chronic infection. ART suppresses viral replication, promotes immune system recovery, reduces the incidence of opportunistic infections, and significantly improves patient survival and quality of life. Modern evidence confirms that timely and continuous ART is essential for reducing HIV-associated morbidity and mortality and preventing sexual transmission of the virus.

Keywords: HIV infection, antiretroviral therapy, viral suppression, CD4+ lymphocytes, immune recovery, drug resistance, opportunistic infections.

Introduction. Human immunodeficiency virus (HIV) infection is a chronic viral disease characterized by progressive damage to the immune system, particularly CD4-positive T lymphocytes. Without effective treatment, the continuous

replication of HIV leads to immune dysfunction, increased susceptibility to opportunistic infections, and the development of acquired immunodeficiency syndrome (AIDS). The development of antiretroviral therapy has substantially changed the prognosis of HIV infection. According to current international recommendations, ART should be offered to all individuals diagnosed with HIV, regardless of their CD4+ lymphocyte count or clinical stage [1,2].

Mechanisms of action of antiretroviral therapy. HIV primarily infects CD4-positive T lymphocytes and uses the cellular machinery to reproduce. Viral replication involves several stages, including attachment to the host cell, reverse transcription of viral RNA into DNA, integration into the host genome, and production of new viral particles. Antiretroviral drugs inhibit different stages of this replication cycle. The main classes include nucleoside and nucleotide reverse transcriptase inhibitors, non-nucleoside reverse transcriptase inhibitors, integrase strand transfer inhibitors, protease inhibitors, and entry inhibitors.

Combination ART uses several active drugs, usually from at least two different drug classes, to achieve effective and sustained viral suppression. Dolutegravir-based regimens are among the preferred initial treatment options in current WHO recommendations because of their efficacy, tolerability, and high genetic barrier to resistance [1].

The influence of ART on viral replication and immune recovery

One of the most important effects of antiretroviral therapy is a rapid reduction in plasma HIV RNA concentration. Following the initiation of effective treatment, viral load usually decreases substantially during the first weeks and may become undetectable within several months, depending on baseline viral load, treatment potency, and adherence [2]. Viral suppression reduces the continuous destruction of CD4-positive T lymphocytes and creates conditions for gradual immune recovery. An increase in CD4+ cell count is an important indicator of treatment effectiveness and improved immunological status.

Immune recovery decreases the risk of opportunistic infections, including tuberculosis, Pneumocystis jirovecii pneumonia, cryptococcosis, and certain viral infections. The extent of CD4+ recovery depends on several factors, particularly the initial CD4+ count, age, duration of untreated infection, and consistency of treatment. Early initiation of ART provides the greatest opportunity to preserve immune function. The INSIGHT START trial demonstrated that immediate treatment in individuals with CD4+ counts above 500 cells/mm³ reduced the risk of serious AIDS-related and non-AIDS-related clinical events compared with deferred treatment. The hazard ratio for the primary composite outcome was 0.43 (95% CI: 0.30–0.62) [3].

ART and prevention of HIV-associated complications. Before the widespread availability of effective ART, HIV infection frequently progressed to advanced immunodeficiency, accompanied by severe opportunistic infections and malignancies. Modern antiretroviral treatment has significantly reduced the frequency of these complications. Sustained viral suppression and immune restoration decrease the incidence of many AIDS-defining conditions. ART also reduces the risk of severe bacterial infections and contributes to a lower frequency of hospitalization. The TEMPRANO trial demonstrated that early ART initiation reduced the risk of severe HIV-related illness, including among individuals with relatively high CD4+ counts [4].

Consequently, long-term HIV management should include not only antiviral treatment but also regular assessment of cardiovascular risk factors, glucose metabolism, lipid profile, renal and hepatic function, and screening for other chronic diseases [2,5].

The role of treatment adherence and drug resistance. Continuous adherence to ART is essential for maintaining viral suppression. Irregular medication intake, treatment interruptions, and inadequate drug exposure may result in viral rebound and the selection of resistant HIV variants. Drug resistance limits future treatment

options and may lead to virological failure. Therefore, patients require regular clinical follow-up, assessment of medication adherence, and monitoring of plasma HIV RNA levels. Viral load testing is the principal method for evaluating virological response. CD4+ lymphocyte monitoring provides additional information about immune recovery, particularly in patients with advanced disease or an incomplete immunological response. Treatment selection should be individualized according to previous therapy, comorbidities, laboratory findings, and patient preferences [1,2].

The impact of ART on quality of life and HIV transmission. Effective antiretroviral therapy has transformed the long-term outlook for people living with HIV. An important public health benefit of ART is the prevention of sexual HIV transmission. The principle known as “Undetectable = Untransmittable” (U=U) means that individuals who maintain an undetectable viral load through effective treatment do not sexually transmit HIV. This evidence emphasizes the importance of treatment adherence, regular viral load monitoring, and uninterrupted access to medical care [5]. Despite these advances, psychological, social, and economic factors may interfere with long-term treatment. HIV-related stigma, depression, limited access to healthcare, and inadequate treatment education can negatively affect adherence. Patient-centered counselling and continuous medical support are therefore essential components of successful ART.

Conclusion. Antiretroviral therapy is the cornerstone of modern HIV management and has fundamentally changed the natural course of the disease. By suppressing viral replication, ART promotes immune recovery, reduces opportunistic infections, prevents progression to AIDS, and improves survival and quality of life. The greatest clinical benefits are achieved when treatment is initiated early and maintained continuously. Regular monitoring of viral load, CD4+

lymphocyte count, treatment tolerability, and possible adverse effects is essential for long-term success.

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