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MODERN AND LABORATORY DIAGNOSTIC METHODS FOR PATIENTS WITH HIV INFECTION

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Abstract: This article examines the processes of identifying and monitoring patients infected with the human immunodeficiency virus (HIV) through modern diagnostic and laboratory methods. In particular, it discusses biochemical, immunological, and molecular methods used before, during, and after the initiation of antiretroviral therapy (ART) to evaluate its effectiveness, as well as the laboratory infrastructure implemented in Uzbekistan. The study methodology is based on a review of literature and analysis of national statistical data. The main section presents the stages of testing, various test systems, diagnostic strategies, and monitoring approaches in detail. The analysis and results section provides evidence on the current state of laboratory infrastructure and testing systems in Uzbekistan. The conclusion highlights the importance of modern diagnostic methods and outlines the existing challenges and recommendations for their implementation in clinical practice.

Keywords: HIV infection, laboratory diagnostics, molecular testing, antiretroviral therapy monitoring, HIV testing in Uzbekistan.

Introduction

The Human Immunodeficiency Virus (HIV) remains one of the major infectious diseases of global public health concern. This virus impairs the immune system, which can lead to the development of Acquired Immunodeficiency Syndrome (AIDS). Today, the number of people living with HIV continues to increase worldwide, making issues related to diagnosis, treatment, and monitoring highly relevant. As of November 1, 2020, the number of people living with HIV in Uzbekistan was reported to be 43,581. Laboratory diagnostics play a crucial role in the early detection, initiation of therapy, and periodic monitoring of HIV patients. Modern diagnostic methods include molecular (e.g., PCR), immunological (e.g., antibody detection), and biochemical tests. According to the Resolution of the Ministry of Health of the Republic of Uzbekistan on “Measures to further improve the system of combating the spread of diseases caused by the Human Immunodeficiency Virus,” efforts are being made to equip diagnostic laboratories with modern technologies and to develop locally produced test systems. Currently, 78 laboratories in Uzbekistan are reported to be conducting HIV diagnostics using ELISA, immunoblot, PCR, and clinical-biochemical analyses. Hence, implementing advanced laboratory testing methods, improving their quality, and strengthening monitoring systems are essential. The main objective of this article is to systematically review modern diagnostic and laboratory testing methods for HIV-infected patients, analyze the current situation in Uzbekistan, and develop recommendations for improvement.

Research Methodology

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This article is primarily based on literature review and situational analysis. The methodological steps of the study included:

1. Literature Selection – Both local (Uzbek) and international sources were reviewed, including textbooks, scientific papers, and government documents. For example, "Clinical Laboratory Diagnosis and Examination Methods in Infectious Diseases" (Orzikulov A.O. et al., 2022) was used to analyze the stages of laboratory testing.

2. Collection of National Data – Open sources were reviewed to collect data on the number of HIV diagnostic laboratories in Uzbekistan, types of tests used, and government funding allocated to diagnostics.

3. Analysis and Synthesis – The collected materials were analyzed to determine the advantages and limitations of modern laboratory methods and identify challenges in their application in Uzbekistan.

4. Development of Recommendations – Based on the results, proposals were formulated to improve the diagnostic and monitoring systems.

This article is not based on experimental or clinical research; rather, it focuses on literature and system analysis. Therefore, its conclusions depend on the accuracy of the reviewed sources.

Main Part

1. Stages of HIV Diagnosis

The process of identifying and managing HIV-infected patients includes three stages: initial screening, confirmatory diagnosis, and monitoring.Screening stage: Rapid tests are performed for individuals in high-risk groups (e.g., those returning from abroad, intravenous drug users, or individuals with a high risk of sexual transmission). In Uzbekistan, screening is mandatory for certain categories, including those returning from abroad.Confirmatory diagnosis: If a screening test is positive, confirmatory tests such as immunoblot or PCR are conducted to verify HIV infection.Monitoring: Includes assessing the patient's response to ART, viral load, CD4+ cell count, and co-infections. Monitoring helps evaluate therapy effectiveness and prevent disease progression.

2. Laboratory Testing Methods

Serological tests: Detect antibodies (IgG, IgM) using enzyme-linked immunosorbent assay (ELISA). In Uzbekistan, ELISA is widely available.

Advantages: Affordable, widely applicable, suitable for screening.

Limitations: Antibody formation takes time; may produce false results.Polymerase Chain Reaction (PCR): Detects viral genetic material (RNA/DNA) and allows early diagnosis. Quantitative PCR is used to measure viral load, essential in ART monitoring. Advantages: Detects infection at early stages, provides quantitative viral data.

Limitations: Expensive, requires skilled staff and strict quality control. CD4+ T-cell count: Reflects immune system status and guides ART decisions. Although specific national data are limited, this indicator is widely used globally. Biochemical tests: Since HIV patients are prone

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to co-infections (e.g., hepatitis B and C) and metabolic disorders, liver function, lipid profile, and renal tests are necessary.Uzbekistan's "Clinical Laboratory Diagnosis and Examination Methods in Infectious Diseases" provides detailed procedures for specimen collection and analysis. Currently, 78 HIV diagnostic laboratories operate nationwide, and the government supports the local production of diagnostic test systems.

3. Clinical Monitoring and Therapy Control

After ART initiation, laboratory monitoring evaluates treatment response through: Viral load (copies/ml): Indicates therapy effectiveness. CD4+ T-cell count: Measures immune recovery. Co-infection biomarkers: Such as hepatitis markers and liver enzymes.

Biochemical parameters: Help detect early side effects of ART. In Uzbekistan, reports indicate that over 79% of HIV patients are covered by ART. Effective monitoring improves quality of life and reduces infection spread.

4. Challenges in Implementing Diagnostic Methods

Despite progress, several challenges persist in Uzbekistan:

High cost of test systems and reagents due to limited budgets;

Shortage of qualified laboratory specialists and complex quality control systems;

Limited production of domestic diagnostic kits;

Weak infrastructure and delayed specimen transport in remote areas.These problems are also reflected in government documents.

5. Integration of Global and National Practices

Internationally, HIV diagnostic and monitoring protocols follow WHO standards. In Uzbekistan, the legal framework for developing diagnostic and monitoring systems is expanding.For example, the Presidential Decree (June 22, 2018) introduced new measures for HIV diagnosis, treatment, and prevention. Moreover, modern educational and scientific materials—such as Orzikulov A.O. et al. (2022)—support the growth of laboratory diagnostic capacity in the country.

Analysis and Results

The analysis of laboratory diagnostic and monitoring systems revealed that:

1. Uzbekistan has developed an infrastructure with 78 active HIV diagnostic laboratories performing ELISA, immunoblot, PCR, biochemical, and immunological analyses.

2. Government funding for reagents and test systems is improving diagnostic capacity.

3. However, challenges such as equipment limitations and logistics issues in rural areas still reduce testing speed and accuracy.

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4. Laboratory-based monitoring of ART is expanding, but data management systems and professional training need further improvement.Overall, the implementation of modern laboratory methods can significantly improve patient outcomes and HIV control in Uzbekistan.

Conclusion

In conclusion, modern laboratory methods for detecting, monitoring, and managing HIV-infected patients are highly effective. Uzbekistan has made significant progress in developing laboratory infrastructure, introducing test systems, and improving monitoring. However, challenges remain in ensuring test quality, expanding services in rural areas, developing domestic test kits, and training qualified laboratory staff.

Recommendations: Further expand the national network of diagnostic laboratories; Develop local production of test systems to reduce costs; Digitize monitoring and unify regional data under a central database; Conduct regular training and quality assurance programs for laboratory staff. If these measures are implemented, Uzbekistan can achieve early HIV diagnosis, effective monitoring, and improved treatment outcomes for all patients.

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