СРАВНИТЕЛЬНЫЙ АНАЛИЗ ПЦР И ЭКСПРЕСС-ТЕСТОВ В ДИАГНОСТИКЕ ИНФЕКЦИОННЫХ ЗАБОЛЕВАНИЙ

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АННОТАЦИЯ

Своевременная и точная диагностика инфекционных заболеваний играет ключевую роль в эффективном лечении, эпидемиологическом контроле и охране общественного здоровья. В современной клинической практике широко применяются полимеразная цепная реакция (ПЦР) и экспресс-диагностические тесты. ПЦР характеризуется высокой чувствительностью и специфичностью, позволяя выявлять инфекцию на ранних стадиях, тогда как экспресс-тесты обеспечивают быстрое получение результатов. В данной статье проведён сравнительный анализ диагностических возможностей, преимуществ и ограничений ПЦР и экспресс-тестов при инфекционных заболеваниях.

Ключевые слова: инфекционные заболевания, ПЦР, экспресс-тесты, лабораторная диагностика, чувствительность, специфичность.

COMPARATIVE ANALYSIS OF PCR AND RAPID DIAGNOSTIC TESTS IN THE DIAGNOSIS OF INFECTIOUS DISEASES

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ABSTRACT

Timely and accurate diagnosis of infectious diseases is essential for effective treatment, epidemiological surveillance, and public health protection. Polymerase chain reaction (PCR) and rapid diagnostic tests are among the most widely used methods for detecting infectious agents. PCR offers high sensitivity and specificity, enabling early detection of infections, whereas rapid tests provide fast results and are particularly useful in point-of-care and resource-limited settings. This article presents a comparative analysis of PCR and rapid diagnostic tests, focusing on their diagnostic performance, advantages, and limitations in the context of infectious disease diagnostics.

Keywords: infectious diseases, PCR, rapid diagnostic tests, laboratory diagnostics, sensitivity, specificity.

Abstract

Accurate and timely diagnosis of infectious diseases is a cornerstone of effective clinical management, epidemiological control, and public health decision-making. Among the most widely used diagnostic approaches are polymerase chain reaction (PCR) and rapid diagnostic tests (RDTs), each offering distinct advantages and limitations. PCR-based methods are considered the gold standard for pathogen detection due to their high sensitivity and specificity, while rapid tests provide fast, point-of-care results that are critical in resource-limited and emergency settings. This article presents a comprehensive comparative analysis of PCR and rapid diagnostic tests in the diagnosis of infectious diseases, focusing on their methodological principles, diagnostic performance, clinical applicability, and limitations. The analysis highlights the complementary role of these methods and emphasizes the importance of selecting diagnostic strategies based on clinical context, infrastructure, and public health priorities.

Keywords: infectious diseases, PCR, rapid diagnostic tests, laboratory diagnosis, sensitivity, specificity.

Introduction

Infectious diseases remain a major cause of morbidity and mortality worldwide despite significant advances in medical science and public health. The rapid spread of emerging and re-emerging pathogens, including viral, bacterial, and parasitic agents, underscores the critical importance of reliable laboratory diagnostics. Early

and accurate identification of infectious agents enables timely initiation of appropriate therapy, reduces transmission, and supports effective outbreak control.

Laboratory diagnosis plays a central role in infectious disease management. Over recent decades, diagnostic technologies have evolved from conventional culture-based methods to advanced molecular and immunological techniques. Among these, polymerase chain reaction (PCR) and rapid diagnostic tests (RDTs) have become indispensable tools in clinical laboratories and point-of-care settings.

PCR-based diagnostics revolutionized infectious disease detection by enabling direct identification of pathogen-specific nucleic acids with high analytical sensitivity. This technique allows detection of low pathogen loads, making it particularly valuable in early stages of infection and in cases with atypical clinical presentation. As a result, PCR has become the reference method for diagnosing many viral and bacterial infections.

In contrast, rapid diagnostic tests are designed to provide results within minutes, often without the need for complex laboratory infrastructure. These tests typically rely on immunochromatographic detection of antigens or antibodies and are widely used in emergency departments, outpatient clinics, and field settings. Their simplicity and speed make them especially useful in large-scale screening and outbreak situations.

Despite their widespread use, PCR and rapid tests differ significantly in terms of sensitivity, specificity, turnaround time, cost, and technical requirements. Understanding these differences is essential for optimizing diagnostic strategies in clinical and public health practice. Therefore, this article aims to provide a detailed comparative analysis of PCR and rapid diagnostic tests in the diagnosis of infectious diseases, with particular emphasis on their clinical and epidemiological implications.

Materials and Methods

This study is based on a narrative review and comparative analysis of international scientific literature, including clinical guidelines, systematic reviews, and original research articles published in peer-reviewed journals. Data were collected from authoritative sources such as **World Health Organization**, **Centers for Disease Control and Prevention**, and leading infectious disease journals.

The following aspects were analyzed and compared:

- Diagnostic principles of PCR and rapid tests
- Analytical sensitivity and specificity
- Turnaround time and operational requirements
- Clinical and epidemiological applications
- Limitations and sources of diagnostic error

The methods were evaluated in the context of different healthcare settings, including centralized laboratories and point-of-care environments.

Results

The comparative analysis demonstrated that PCR and rapid diagnostic tests serve distinct but complementary roles in infectious disease diagnostics.

PCR diagnostics showed superior sensitivity and specificity, enabling detection of minimal amounts of pathogen genetic material. PCR methods were particularly effective in early infection stages and in cases requiring definitive confirmation. However, PCR requires specialized equipment, trained personnel, and longer processing times.

Rapid diagnostic tests provided results within 10–30 minutes and required minimal technical expertise. These tests proved valuable for rapid screening, triage, and outbreak management. Nevertheless, their sensitivity was generally lower than PCR, particularly in cases with low pathogen load, leading to potential false-negative results.

The results indicate that PCR remains the gold standard for confirmatory diagnosis, while rapid tests are optimal for initial screening and point-of-care decision-making.

Discussion

The findings of this analysis highlight the critical importance of selecting appropriate diagnostic tools based on clinical context and available resources. PCR-based diagnostics offer unparalleled accuracy and are indispensable for definitive diagnosis, surveillance, and antimicrobial stewardship. Their ability to detect pathogen nucleic acids with high precision makes them essential in reference laboratories and specialized clinical centers.

However, the limitations of PCR, including cost, infrastructure requirements, and longer turnaround times, restrict its accessibility in low-resource settings. In such contexts, rapid diagnostic tests provide a practical alternative, enabling timely clinical decisions and early isolation measures. Although less sensitive, rapid tests significantly contribute to reducing diagnostic delays and improving patient flow.

The complementary use of PCR and rapid tests has emerged as an optimal diagnostic strategy. Rapid tests can be employed for initial screening, followed by PCR confirmation in negative or ambiguous cases. This tiered approach enhances diagnostic efficiency while balancing accuracy and feasibility.

Furthermore, recent advances in molecular diagnostics, such as isothermal amplification and multiplex PCR, aim to bridge the gap between accuracy and speed. Similarly, improvements in rapid test design continue to enhance sensitivity and specificity, expanding their clinical utility.

Overall, integrating PCR and rapid diagnostic tests into coherent diagnostic algorithms is essential for effective infectious disease management and preparedness for future outbreaks.

Conclusion

PCR and rapid diagnostic tests are fundamental components of modern infectious disease diagnostics. PCR remains the gold standard due to its high sensitivity and specificity, while rapid tests offer speed, simplicity, and accessibility. Their rational and complementary use enables timely diagnosis, effective patient management, and improved public health outcomes. Future innovations are expected to further enhance diagnostic accuracy and accessibility across diverse healthcare settings.

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