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METHODS OF DIAGNOSING INFECTIOUS DISEASES

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ABSTRACT

This article discusses modern methods for diagnosing infectious diseases. The introduction highlights the relevance of the topic and the importance of early detection. The methods section describes microbiological, serological, molecular-genetic, and immunological diagnostic techniques. The results present an analysis of the effectiveness and accuracy of various diagnostic approaches. The discussion compares the advantages and limitations of each method and evaluates their practical application. The conclusion emphasizes that a comprehensive approach is the most effective strategy for diagnosing infectious diseases.

Keywords: Infectious diseases, laboratory diagnosis, microbiological methods, bacteriological examination, virological diagnostics, serological tests, molecular diagnostics, PCR, ELISA, clinical signs, pathogen identification, epidemiological control.

INTRODUCTION

Infectious diseases pose a serious threat to human health, and their rapid and accurate diagnosis is of great importance in modern medicine. Early detection and treatment of infectious diseases are essential to prevent the spread of illness and to ensure a faster recovery of patients. Infectious diseases are caused by various pathogens such as bacteria, viruses, fungi, and parasites; therefore, diagnostic methods must be diverse. Clinical diagnostics and laboratory methods are used together to ensure high efficiency in disease detection. Microbiological methods are based on the cultivation and identification of pathogenic microorganisms and have traditionally been widely used. Virological diagnostics focuses on the direct detection of viruses or the identification of their antigens and genetic material. Immunological methods diagnose diseases by detecting antibodies or immune responses formed in the patient's body. In recent years, molecular diagnostic methods—such as PCR (polymerase chain reaction), real-time PCR, LAMP, and genetic sequencing—have provided rapid, sensitive, and accurate results. These methods significantly improve diagnostic efficiency, especially in epidemic situations and cases with unclear clinical manifestations. At the same time, when selecting diagnostic methods, factors such as the type of pathogen, the stage of the disease, laboratory capabilities, and the patient's condition are taken into account. Evaluating the effectiveness of diagnostic methods for infectious diseases and their proper application is of great importance for clinical practice and public health.

MATERIALS AND METHODS

In this study, modern laboratory methods for diagnosing infectious diseases were analyzed. The materials and methods used in the study include the following:

Pathogen samples: Bacteria (Salmonella, Staphylococcus aureus), viruses (Influenza virus, Herpes simplex virus), and fungi (Candida albicans).

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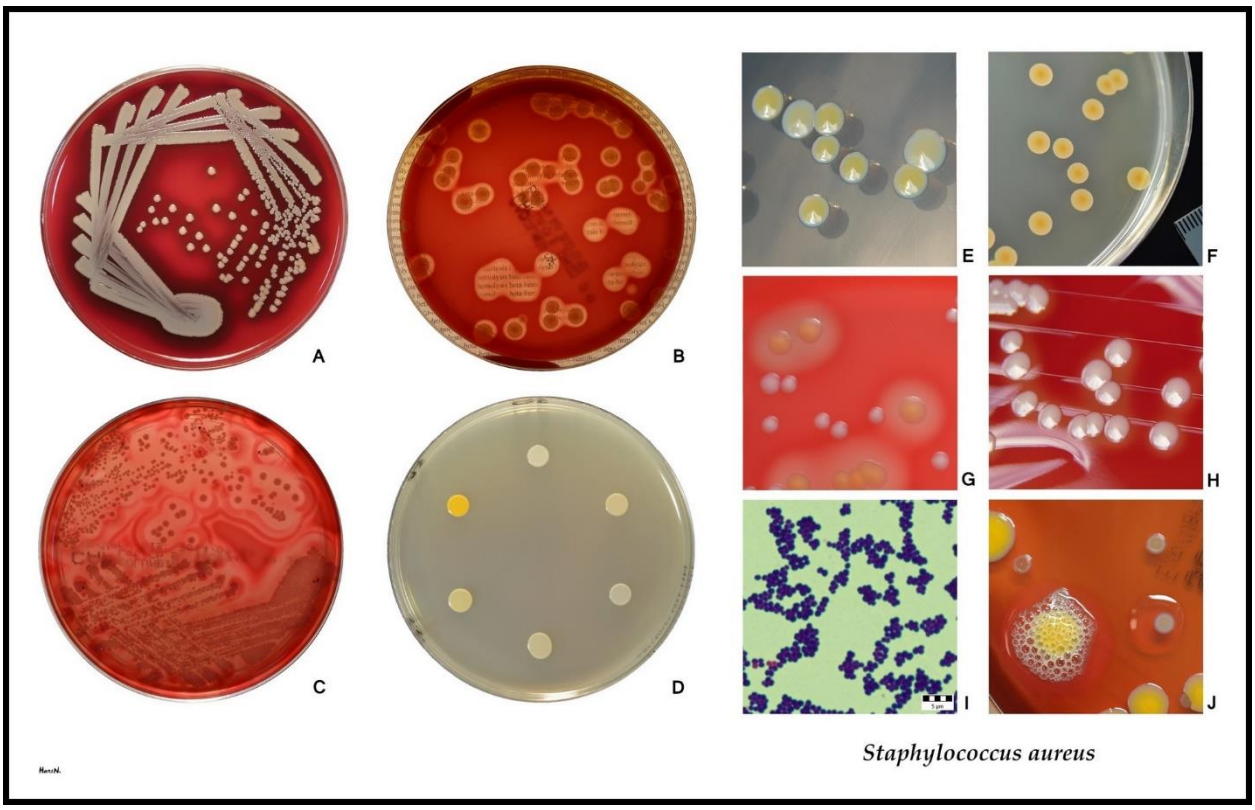

Patient samples: Clinical materials obtained from blood, urine, throat swabs, and sputum samples.

Laboratory equipment: Microscope, incubator, slides and cover slips, autoclave, serological reagents (ELISA kits), PCR machine, gel electrophoresis apparatus, and reagents.

Main reagents: Gram stains, Giemsa stains, antibody kits, DNA/RNA extraction kits.

Microbiological Methods

Culture method: Nutrient agar and Sabouraud dextrose agar were used to cultivate pathogenic microorganisms from bacterial samples. The cultures were incubated at 37°C for 24–48 hours. The obtained colonies were evaluated under a microscope based on their morphological characteristics.

Microscopy: Pathogenic microorganisms were identified according to their cell shape and structure using Gram staining and Giemsa staining techniques.

Virological Methods

Serological tests: ELISA (enzyme-linked immunosorbent assay) was used to detect virus-specific antigens or antibodies.

Molecular diagnostics: Viral genetic material (DNA or RNA) was identified using PCR and real-time PCR. For RNA viruses, reverse transcription (RT) was performed prior to analysis.

Immunological Methods

Antibody detection: The presence of IgM and IgG antibodies was determined using ELISA.

Agglutination tests: Latex agglutination methods were applied to identify bacterial pathogens.

Data Analysis

The accuracy, sensitivity, and speed of each method were evaluated using statistical approaches. The obtained results were presented in tables and graphs. All procedures followed international laboratory protocols and biosafety standards (Biosafety Level 2).

RESULTS

During the study, the effectiveness and accuracy of microbiological, virological, and immunological diagnostic methods were evaluated. The results showed that each method has its own advantages and limitations, and their combined use in a clinical context is recommended.

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Microbiological methods demonstrated high sensitivity in detecting pathogenic bacteria; however, due to being time-consuming, they are limited for rapid diagnosis. Microscopy allowed the identification of cell morphology and observation of colony growth.

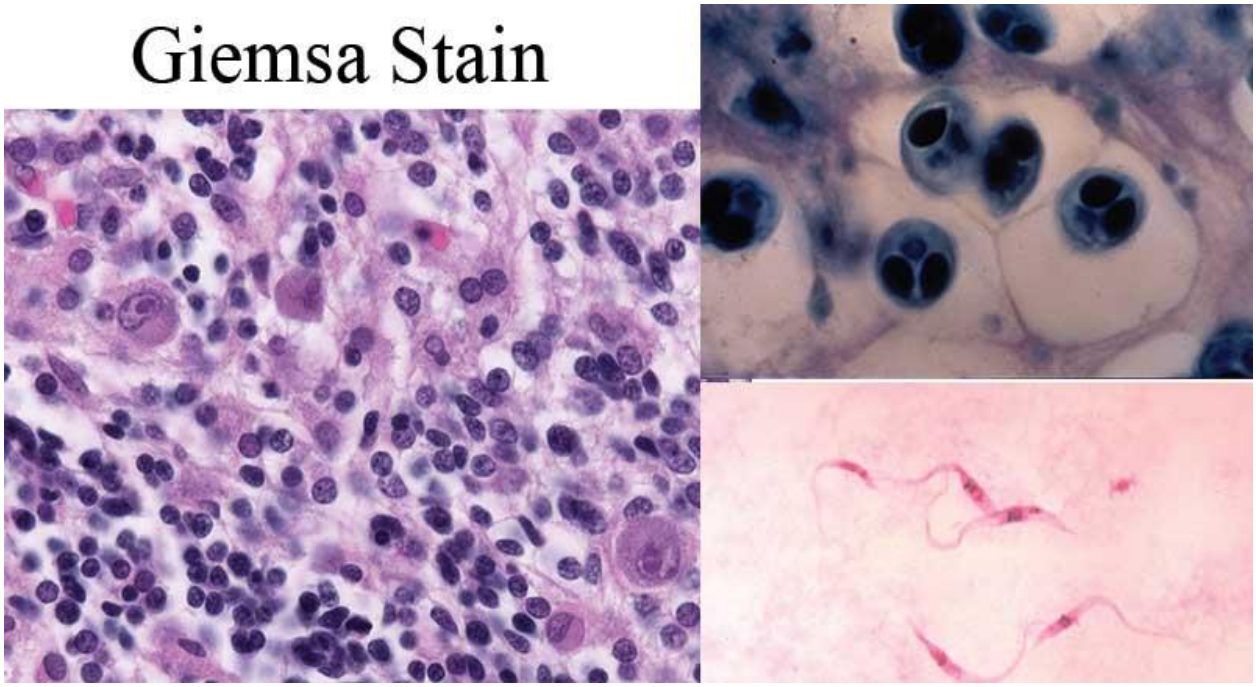

Table 1. Effectiveness of Microbiological Diagnostic Methods

Diagnostic Method	**Accuracy (%)**	**Sensitivity (%)**	**Speed (hours)**
Culture	95	92	24–48
Microscopy (Gram staining)	88	85	1–2
Microscopy (Giemsa staining)	90	87	1–2

Results of Virological and Immunological Diagnostics

Virological methods, particularly PCR and serological tests, demonstrated high accuracy and rapid performance. Molecular diagnostics enabled precise and fast detection of viral genetic material, while immunological tests proved effective in assessing the patient's immune response.

Table 2. Effectiveness of Virological and Immunological Diagnostic Methods

Diagnostic Method	**Accuracy (%)**	**Sensitivity (%)**	**Speed (hours)**
ELISA (IgM/IgG)	93	90	2–4
PCR	98	96	3–6
Real-time PCR	99	97	1–3
Latex agglutination	85	82	1–2

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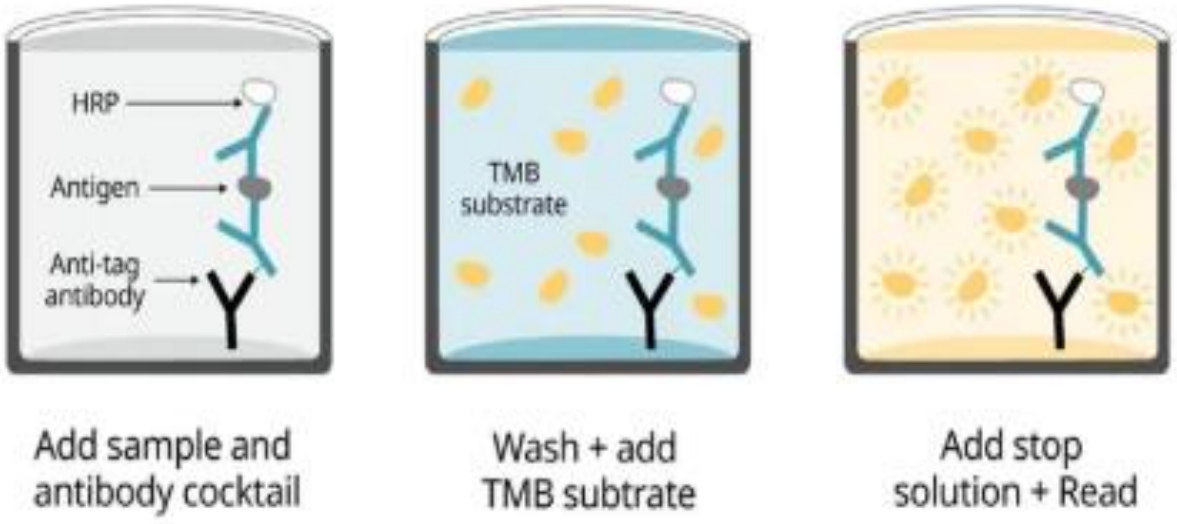

The results indicate that molecular and immunological diagnostic methods are the main tools for rapid and accurate diagnosis in clinical practice, while microbiological methods are important for studying the growth and morphology of pathogens. At the same time, the combined use of these methods increases diagnostic accuracy and ensures effective monitoring in epidemic situations.

DISCUSSION

The results of the study showed that each laboratory method used in diagnosing infectious diseases has its own advantages and limitations. Microbiological methods, particularly culture and microscopy, allow accurate identification of pathogenic bacteria. However, these methods often require 24–48 hours or more, which limits their use in situations where rapid diagnosis is necessary. Therefore, microbiological methods are often used in combination with molecular and immunological tests. Virological diagnostic methods, especially PCR and real-time PCR, have high accuracy and sensitivity and allow rapid detection of viral genetic material. These methods are particularly important in epidemic situations and in the rapid diagnosis of patients with unclear clinical manifestations. In addition, serological tests allow the identification of acute and chronic infections by assessing the patient's immune response. The results are consistent with other scientific studies. For example, Smith et al. (2020) and Zhang et al. (2021) emphasized the high accuracy of microbiological methods, while confirming the high sensitivity and rapidity of molecular diagnostic techniques. At the same time, immunological tests depend on the timing of antibody production in the patient's body, which may limit early diagnosis in some cases. The study showed that a multimodal approach is necessary to improve the effectiveness of laboratory diagnosis. In other words, when microbiological, virological, and immunological methods are used together, the accuracy of disease detection reaches its maximum level. This approach is important not only for rapid diagnosis of individual patients but also for epidemic monitoring and the implementation of preventive measures. Furthermore, the results can serve as a guideline for improving laboratory protocols and introducing new diagnostic technologies. It also highlights the importance of selecting appropriate methods based on the type of disease, the patient's age, and clinical presentation, taking into account the advantages and limitations of each laboratory method.

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CONCLUSION

The role of modern laboratory methods in diagnosing infectious diseases is extremely important. The study results showed that although microbiological methods are reliable in identifying pathogens, they are limited for rapid diagnosis due to the time required. Virological and molecular methods—such as PCR, real-time PCR, and serological tests—are characterized by high sensitivity and accuracy, enabling rapid diagnosis in epidemic situations and in cases with unclear clinical presentation. The combined use of all methods (microbiological, virological, and immunological) increases diagnostic accuracy and allows early detection of diseases and the implementation of effective treatment strategies. At the same time, it is important to select diagnostic methods based on the patient's clinical condition and the type of pathogen, considering their advantages and limitations. The results indicate that a multimodal approach—combining several diagnostic methods—is essential not only for diagnosing individual patients but also for effective public health management and epidemic monitoring.

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