Rapid evolution of infectious disease diagnostics.

Yara Hassan*

Department of Clinical Microbiology, American University of Beirut, Beirut, Lebanon

Introduction

The field of infectious diseases is continuously evolving, necessitating sophisticated diagnostic tools that are both rapid and accurate. Innovations in this area are critical for effective disease management, public health, and controlling antimicrobial resistance globally.

This paper surveys the latest advancements in molecular diagnostic techniques for infectious diseases, highlighting technologies like next-generation sequencing, CRISPR-based diagnostics, and microfluidic systems, emphasizing their role in rapid, accurate, and high-throughput pathogen identification and antimicrobial resistance detection [1].

This review assesses the current landscape and future trajectory of point-of-care (POC) diagnostics for infectious diseases, focusing on their benefits for rapid diagnosis, guiding treatment decisions, and public health responses, particularly in resource-limited settings. It also discusses challenges and opportunities for innovation [2].

This article explores the transformative potential of CRISPR-based diagnostic tools in infectious disease detection. It highlights their high sensitivity, specificity, and rapid turnaround times, discussing various platforms and their applications in pathogen identification and antimicrobial resistance profiling [3].

This practical guide details the application of next-generation sequencing (NGS) in diagnosing infectious diseases. It covers various NGS methodologies, their advantages in pathogen discovery, outbreak surveillance, and antimicrobial resistance detection, and provides insights into implementation and data interpretation [4].

This review examines the growing role of Artificial Intelligence (AI) in infectious disease diagnostics, covering its use in image analysis, pathogen identification, predicting outbreaks, and optimizing antimicrobial stewardship, while also addressing challenges like data quality and regulatory frameworks [5].

This article reviews recent progress and existing challenges in developing microfluidic devices for diagnosing infectious diseases. It highlights how these miniature platforms offer advantages in terms of portability, reduced reagent consumption, and rapid analysis, crucial for point-of-care applications, but also discusses hurdles in mass production and standardization [6].

This review focuses on diagnostics that analyze the host's immune response rather than directly detecting pathogens. It discusses biomarkers, transcriptomics, and proteomics as approaches for early and accurate diagnosis of infectious diseases, especially when direct pathogen detection is challenging, and considers the potential for differentiating between bacterial and viral infections [7].

This paper reviews the latest innovations in biosensor technology for diagnosing infectious diseases. It covers electrochemical, optical, and mass-based biosensors, emphasizing their high sensitivity, rapid detection capabilities, and potential for integration into point-of-care platforms to improve clinical outcomes [8].

This review focuses on isothermal amplification technologies, like LAMP and RPA, for point-of-care diagnosis of infectious diseases. It highlights their advantages over PCR, such as speed, simplicity, and applicability in resource-limited settings, discussing various methods and their current and potential clinical uses [9].

This paper delves into the utility of mass spectrometry (MS) in clinical microbiology, particularly for infectious disease diagnostics. It covers applications ranging from rapid pathogen identification (e.g., MALDI-TOF MS) to detecting antimicrobial resistance mechanisms, emphasizing its accuracy and speed for improving patient management [10].

These diverse advancements collectively signify a paradigm shift towards more effective and accessible infectious disease diagnostics, promising substantial improvements in global health outcomes.

Conclusion

The field of infectious disease diagnostics is undergoing rapid evolution, driven by the need for faster, more accurate, and high-throughput methods. Key advancements include sophisticated

***Correspondence to:** Yara Hassan, Department of Clinical Microbiology, American University of Beirut, Beirut, Lebanon. E-mail: yara.hassan@aub.edu.lb

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molecular diagnostic techniques such as next-generation sequencing (NGS), CRISPR-based diagnostics, and microfluidic systems, which are proving instrumental in pathogen identification and detecting antimicrobial resistance. Point-of-care (POC) diagnostics are also transforming the landscape, offering rapid results crucial for treatment decisions and public health, especially in resource-limited settings.

CRISPR-based tools are particularly noted for their high sensitivity, specificity, and quick turnaround, with applications spanning pathogen identification and antimicrobial resistance profiling. NGS provides a practical guide for diagnostics, excelling in pathogen discovery, outbreak surveillance, and resistance detection. Artificial Intelligence (AI) plays an increasing role, improving image analysis, pathogen identification, outbreak prediction, and optimizing antimicrobial stewardship. Microfluidic devices offer advantages in portability, reduced reagent use, and rapid analysis for POC applications.

Beyond direct pathogen detection, host response-based diagnostics utilize biomarkers, transcriptomics, and proteomics for early and accurate diagnosis, and for differentiating between bacterial and viral infections. Biosensor technology, encompassing electrochemical, optical, and mass-based sensors, brings high sensitivity and rapid detection for improved clinical outcomes. Isothermal amplification technologies like LAMP and RPA offer speed and simplicity, making them ideal for POC use in various settings. Finally, mass spectrometry, particularly MALDI-TOF MS, provides accurate and rapid pathogen identification and antimicrobial resistance testing, significantly enhancing patient management. This collective progress underscores a move towards integrated, versatile diagnostic solutions.

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