



Artificial Intelligence and Machine Learning in Clinical Microbiology: Advancing Diagnostics with Responsible Innovation

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LETTER TO THE EDITOR

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Dear editor,

Artificial intelligence (AI) and machine learning (ML) are transforming clinical microbiology by enabling faster, more accurate, and data-driven diagnostic practices. The increasing burden of antimicrobial resistance, emerging infectious diseases, and growing laboratory workloads has accelerated the adoption of AI-based technologies to improve diagnostic efficiency and support clinical decision-making. Rather than replacing microbiologists, AI serves as a complementary tool that enhances laboratory performance by assisting with data analysis, pattern recognition, and workflow optimization [1,2].

Modern clinical microbiology laboratories generate extensive data from microscopy, culture, antimicrobial susceptibility testing, molecular diagnostics, mass spectrometry, and whole-genome sequencing. Interpreting these datasets rapidly and accurately is becoming increasingly challenging. ML algorithms can identify complex relationships within laboratory data, facilitating rapid pathogen identification, prediction of antimicrobial resistance, and improved interpretation of diagnostic results. The integration of AI with genomic

technologies further supports precision diagnostics and personalized management of infectious diseases [3,4].

The COVID-19 pandemic highlighted the value of AI in infectious disease surveillance and laboratory medicine. AI-based analytical models have been used to detect outbreaks, monitor disease transmission, and analyze antimicrobial resistance trends using large-scale clinical and epidemiological datasets. Similarly, automated image analysis has improved the consistency of digital microscopy while reducing reporting times, enabling laboratory professionals to focus on diagnostically complex cases requiring expert judgment [5,6].

AI is also strengthening antimicrobial stewardship by supporting evidence-based antimicrobial prescribing. Predictive algorithms that integrate microbiological findings with patient-specific clinical information can assist clinicians in selecting appropriate empirical therapy before conventional susceptibility results become available. Such approaches have the potential to improve patient outcomes, reduce unnecessary antibiotic exposure, and help curb the spread of antimicrobial resistance. However, these predictive models require

continuous validation across different healthcare settings to ensure reliability and generalizability [2,6].

Despite its considerable promise, several challenges limit the widespread implementation of AI in clinical microbiology. The performance of ML models depends on the quality, diversity, and representativeness of training datasets. Models developed using data from a single institution may not perform consistently in different populations or healthcare systems. Additional concerns include algorithm transparency, data privacy, cybersecurity, ethical governance, and regulatory oversight. Consequently, AI should be viewed as a decision-support technology that complements rather than replaces the expertise and clinical judgment of trained microbiologists [1,7].

Generative AI has also emerged as a useful tool for scientific writing, literature review, education, and laboratory documentation. Nevertheless, these systems may generate inaccurate information or unsupported references, emphasizing the need for careful human verification before clinical or academic use. Responsible implementation of AI requires transparency, rigorous validation, and adherence to ethical standards [7].

The future of clinical microbiology will depend on successful collaboration between laboratory professionals, clinicians, data scientists, and policymakers. With appropriate validation and responsible governance, AI has the potential to improve diagnostic accuracy, laboratory efficiency, infectious disease surveillance, and antimicrobial stewardship while preserving the indispensable role of microbiologists in clinical interpretation and patient care. Thoughtful integration of AI into routine laboratory practice will strengthen healthcare systems and improve outcomes in the face of evolving infectious disease challenges [1,4,6].

Competing interests

The author declares no competing interests.

References

- [1]. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. *Nat Med.* 2019;25(1):44–56.
- [2]. Peiffer-Smadja N, Rawson TM, Ahmad R, Buchard A, Georgiou P, Lescure FX, et al. Machine learning for clinical decision support in infectious diseases: a narrative review. *Clin Microbiol Infect.* 2020;26(5):584–95.
- [3]. van Belkum A, Bachmann TT, Lüdke G, Lisby JG, Kahlmeter G, Mohess A, et al. Developmental roadmap for antimicrobial susceptibility testing systems. *Nat Rev Microbiol.* 2019;17(1):51–62.
- [4]. Bassetti M, Peghin M, Vena A, Giacobbe DR. Artificial intelligence in infectious diseases. *Clin Microbiol Infect.* 2024;30(3):301–8.
- [5]. Miotto R, Wang F, Wang S, Jiang X, Dudley JT. Deep learning for healthcare: review, opportunities and challenges. *Brief Bioinform.* 2018;19(6):1236–46.
- [6]. World Health Organization. Global antimicrobial resistance and use surveillance system (GLASS) report 2024. Geneva: World Health Organization; 2024. Available from <https://www.who.int/initiatives/glass>
- [7]. Nature Medicine. Artificial intelligence in medicine must be transparent and trustworthy. *Nat Med.* 2024;30:1–2.