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Point-of-care microbiology: Bringing the lab to the bedside.

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Introduction

Infectious diseases remain a leading cause of morbidity and mortality worldwide, and timely diagnosis is critical for effective treatment and containment. Traditionally, microbiological diagnostics have relied on centralized laboratories, often resulting in delays that compromise patient care. Point-of-care (POC) microbiology is transforming this landscape by enabling rapid, bedside detection of pathogens, bridging the gap between laboratory science and clinical decision-making. Point-of-care microbiology refers to diagnostic tools and technologies that allow clinicians to detect and identify infectious agents directly at the site of patient care—whether in hospitals, clinics, or remote settings. These tests are designed to be fast, user-friendly, and minimally reliant on specialized infrastructure [1].

Examples include lateral flow assays for influenza and COVID-19, portable PCR devices for tuberculosis, and handheld readers for urinary tract infections. By delivering results within minutes to hours, POC microbiology empowers clinicians to initiate targeted therapy, reduce empirical antibiotic use, and improve patient outcomes. Time is of the essence in infectious disease management. Delays in diagnosis can lead to: Progression of disease and complications. Increased transmission risk. Inappropriate antibiotic use and resistance. Longer hospital stays and higher costs. POC microbiology addresses these challenges by providing actionable results during the patient encounter. For instance, rapid antigen tests for streptococcal pharyngitis allow immediate treatment decisions, while POC molecular assays for sepsis can guide early antimicrobial therapy—potentially saving lives [2].

These paper-based tests detect antigens or antibodies using labeled particles. Widely used for respiratory viruses, malaria, and HIV, LFIAs are inexpensive, portable, and require minimal training. Techniques like loop-mediated isothermal amplification (LAMP) enable DNA/RNA detection without thermal cycling. LAMP-based tests for tuberculosis and dengue are gaining traction in low-resource settings. These platforms miniaturize laboratory processes onto a single chip, allowing multiplexed detection of pathogens from small sample volumes. They offer high sensitivity and integration with digital readouts [3].

CRISPR-Cas systems are being adapted for pathogen detection, offering specificity and speed. SHERLOCK and DETECTR platforms have shown promise for SARS-CoV-2 and other viruses. Compact PCR machines and nanopore sequencers enable molecular diagnostics in field settings. These tools are revolutionizing outbreak response and surveillance. POC microbiology is being deployed across diverse clinical environments: Rapid tests for influenza, RSV, and COVID-19 guide isolation and treatment. Strep throat and UTI tests reduce unnecessary antibiotic prescriptions. Sepsis panels accelerate pathogen identification and antimicrobial stewardship. Portable diagnostics overcome infrastructure barriers, improving access to care [4].

POC tools support surveillance and containment of diseases like Ebola, cholera, and Zika. Some tests have lower sensitivity compared to lab-based methods, risking false negatives. Ensuring consistent performance across settings and operators is critical. Linking POC results with electronic health records and public health databases remains a challenge. Navigating diverse regulatory landscapes can delay deployment. While some tests are affordable, others require investment in devices and consumables. POC microbiology plays a vital role in combating antimicrobial resistance (AMR). By enabling pathogen-specific diagnosis, it reduces empirical antibiotic use and promotes targeted therapy. Rapid detection of resistance markers—such as MRSA, ESBLs, and

carbapenemases—guides appropriate treatment and infection control. In resource-limited settings, POC diagnostics can help monitor resistance trends and inform public health strategies. Integration with surveillance networks like WHO's GLASS enhances global efforts against AMR [5].

Conclusion

Algorithms can interpret test results, predict outbreaks, and optimize diagnostics. Mobile apps and camera-based readers enable remote diagnostics and data sharing. Continuous monitoring of biomarkers may detect infections before symptoms arise. Simultaneous detection of multiple pathogens from a single sample will streamline workflows. Point-of-care microbiology is reshaping infectious disease diagnostics by bringing the lab to the bedside. It offers speed, accessibility, and precision—qualities essential for modern healthcare. While challenges remain, continued investment and innovation will ensure that POC microbiology fulfills its potential to improve patient care, reduce resistance, and strengthen global health systems.

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