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Opinion Article

Advances in Point-of-Care Molecular Diagnostics

Nguyen Thi Lan*

Department of Molecular Pathology, Hanoi Medical University, Hanoi, Vietnam.

ABOVE THE STUDY

Point-Of-Care (POC) molecular diagnostics represent one of the most significant shifts in modern diagnostic medicine, moving sophisticated laboratory testing closer to the patient and enabling rapid, actionable clinical decisions. In my opinion, this transition is not merely a technological upgrade but a structural rethinking of how healthcare is delivered, especially in time-sensitive conditions and resource-limited settings. By integrating molecular precision with bedside accessibility, POC diagnostics are redefining the boundaries between laboratory science and clinical practice.

At the heart of POC molecular diagnostics are technologies capable of detecting nucleic acids, proteins, or pathogens outside centralized laboratories. Methods such as isothermal amplification based detection systems, and lab-on-a-chip platforms have significantly reduced the need for complex instrumentation and long turnaround times. These innovations allow clinicians to obtain highly specific molecular information within minutes to hours, rather than days. In my view, this speed is particularly transformative in infectious diseases, where early detection directly influences transmission control and patient outcomes.

One of the most impactful applications of POC molecular diagnostics has been in infectious disease management. During recent global outbreaks, rapid molecular testing enabled decentralized screening, reducing the burden on centralized laboratories. POC tests for respiratory viruses, sexually transmitted infections, and blood-borne pathogens have improved case detection rates and facilitated timely treatment initiation. Importantly, these tools also support antimicrobial stewardship by distinguishing viral from bacterial infections, thereby reducing unnecessary antibiotic use.

Beyond infectious diseases, POC molecular diagnostics are increasingly being explored in oncology. Liquid biopsy-based POC platforms, although still in early development, aim to detect circulating tumor Deoxyribonucleic Acid (DNA) or specific cancer-associated mutations at the bedside. If successfully implemented, this could revolutionize cancer screening and monitoring, especially in settings where access to advanced imaging or molecular laboratories is limited. In my opinion, this could significantly reduce diagnostic delays that often lead to late-stage cancer detection.

Another important area of advancement is maternal and neonatal health. POC molecular tests for conditions such as group *B Streptococcus*, human papillomavirus, and genetic disorders offer the potential for immediate decision-making during prenatal and perinatal care. Rapid diagnostics in these contexts can prevent complications and improve long-term health outcomes for both mothers and infants. The ability to perform molecular testing at the first point of contact is particularly valuable in rural and underserved regions.

Despite these advancements, several challenges continue to limit widespread adoption. One major issue is the balance between simplicity and analytical performance. While POC devices are designed for ease of use, maintaining laboratory-level sensitivity and specificity remains difficult. In my view, ensuring diagnostic accuracy without compromising usability is one of the central engineering challenges in this field.

Another limitation is cost and scalability. Although POC technologies reduce infrastructure requirements, the devices themselves and associated consumables can still be expensive for low-resource healthcare systems. Additionally, supply chain constraints and maintenance requirements can hinder long-term sustainability. Addressing these issues will be essential to ensure equitable access to these technologies globally.

Data integration is also an emerging concern. Many POC molecular devices generate valuable diagnostic data that could contribute to broader public health surveillance systems. However, without proper digital infrastructure and interoperability standards, this data often remains isolated. In my opinion, integrating POC diagnostics with cloud-based health platforms and artificial intelligence could enhance disease tracking, outbreak prediction, and clinical decision support.

Training and user competency represent another important factor. Although POC devices are designed for minimal operator dependency, correct sample handling and interpretation are still

Correspondence to Nguyen Thi Lan. Department of Molecular Pathology, Hanoi Medical University, Hanoi, Vietnam. E-mail: lan.nguyen@hmu.edu.vn

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critical for reliable results. Inadequate training can lead to errors that compromise diagnostic accuracy. Therefore, continuous education and standardized protocols are essential components of successful implementation.

Looking forward, the future of POC molecular diagnostics is likely to be shaped by further miniaturization, automation, and integration with digital health ecosystems. CRISPR-based detection systems, smartphone-enabled readers, and fully automated microfluidic platforms are already pushing the boundaries of what is possible outside traditional laboratories. In my view, these innovations will eventually enable near-complete decentralization of molecular testing.

In conclusion, point-of-care molecular diagnostics represent a major advancement in clinical medicine by combining speed, accuracy, and accessibility. In my opinion, their greatest value lies in democratizing access to high-quality diagnostic information, particularly in underserved regions and time-critical clinical scenarios. While challenges related to cost, accuracy, and infrastructure remain, continued technological innovation and integration with digital health systems are likely to establish POC molecular diagnostics as a central pillar of future healthcare delivery.