International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 04 | April - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

# Rapid Diagnostic Techniques in Infectious Diseases: Technological Advances and Clinical Implications for Early Detection and Precision Treatment

Dr. Kriti Varshney[1] | Mr. Ketan Sharma[2] | Dr. Rashmi Sharma[3]
[1]*Professor, Department of Microbiology, Saraswathi Institute of Medical Sciences, Hapur*
[2]*Prof Cum Vice Principal, Community Health Nursing (CHN), Saraswathi College of Nursing, Hapur*
[3]*Professor, Department of Pharmacognosy, Saraswathi College of Pharmacy, Hapur*

**Abstract**
Rapid diagnostic technologies have transformed the clinical management of infectious diseases by enabling early pathogen detection, improving treatment decision-making, and supporting effective infection control strategies. Traditional culture-based diagnostics often require 24–72 hours for results, delaying clinical decisions and increasing the risk of inappropriate empirical therapy. Modern rapid diagnostic techniques including molecular assays, biosensor technologies, nucleic acid amplification tests (NAAT), and point-of-care (POC) testing provide faster, more accurate pathogen identification. This cross-sectional analytical study examines the effectiveness and clinical utility of rapid diagnostic techniques across 226 diagnostic cases from hospital laboratories and infectious disease surveillance programmes. Rapid diagnostic technologies significantly reduce detection time and improve diagnostic accuracy compared with conventional methods. The diagnostic method had the strongest association with treatment initiation time ($F=7.41$, $p=0.001$). AI and digital health system integration further enhances disease surveillance and precision medicine in infectious disease management.
Keywords: Rapid diagnostics, point-of-care testing, PCR, LAMP, biosensors, AI diagnostics, infectious diseases, precision medicine.

## 1. Introduction

The ability to rapidly and accurately identify infectious pathogens is foundational to effective clinical management of infectious diseases, enabling targeted antimicrobial therapy, appropriate infection control measures, and timely public health responses (Devi et al., 2025; Swadhi et al., 2026). Delays in pathogen identification inherent to conventional culture-based diagnostic approaches generate critical management windows during which patients may receive inappropriate empirical therapy, spread infections to susceptible contacts, and experience avoidable disease progression (Basha et al., 2025; Venice et al., 2025a). The development of rapid diagnostic technologies molecular, immunological, and biosensor-based has dramatically compressed the diagnostic timeline while simultaneously improving sensitivity and specificity beyond the capabilities of conventional methods (Venice et al., 2025b; Akila et al., 2025). The integration of AI and machine learning into rapid diagnostic workflows represents the current frontier of diagnostic innovation, enabling pattern recognition across complex diagnostic datasets, automated quality control, and predictive modelling of diagnostic outcomes from point-of-care data streams (Shanthi et al., 2025; Arockia et al., 2025). Digital health platforms that integrate rapid diagnostic results with electronic health records, clinical decision support systems, and public health surveillance networks create an interconnected diagnostic ecosystem in which actionable clinical and epidemiological intelligence flows rapidly from the point of testing to the point of decision (Venice et al., 2025c; Vettriselvan et al., 2025c). This study evaluates the diagnostic performance and clinical utility of rapid diagnostic techniques in infectious disease management at Saraswathi Institute of Medical Sciences.

## 2. Literature Review

### 2.1 Molecular Rapid Diagnostics

Nucleic acid amplification tests including real-time PCR, LAMP, and CRISPR-based diagnostic platforms have achieved the highest sensitivity and specificity among available rapid diagnostic technologies, enabling detection of pathogen nucleic acids within minutes to hours of sample collection (Basha et al., 2025; Venice et al., 2025a). The clinical impact of molecular rapid diagnostics is most clearly demonstrated in bacterial meningitis, sepsis, respiratory tract infections, and sexually transmitted infections where early pathogen identification enables targeted antimicrobial selection that reduces treatment duration, adverse effects, and selective pressure for resistance (Swadhi et al., 2026; Devi et al., 2025). The recent development of syndromic

multiplex panels that simultaneously identify multiple pathogens from a single clinical sample has further enhanced the efficiency of molecular diagnostics in emergency and critical care settings (Venice et al., 2025b; Akila et al., 2025).

**2.2 Point-of-Care Testing and Biosensor Technologies**

Point-of-care diagnostic platforms that deliver laboratory-quality results at the bedside, in primary care settings, or in community environments without requiring centralised laboratory infrastructure have substantially democratised rapid diagnostic access (Shanthi et al., 2025; Venice et al., 2025c). Lateral flow immunoassays used for rapid detection of influenza, COVID-19, malaria, HIV, and other priority pathogens provide results within 15–30 minutes at low cost and minimal technical skill requirement, enabling rapid clinical triage and infection control decisions in resource-constrained settings (Vettriselvan et al., 2025a; Meena et al., 2025). Biosensor platforms including electrochemical, optical, and piezoelectric sensors offer the potential for real-time, continuous pathogen monitoring in clinical and public health environments, with AI-powered signal interpretation enabling automated result generation without skilled laboratory personnel (Basha et al., 2025; Venice et al., 2025d).

**2.3 AI and Digital Integration in Diagnostics**

The integration of AI and digital health technologies into rapid diagnostic workflows is creating fundamentally new possibilities for infectious disease detection and management (Venice et al., 2025a; Arockia et al., 2025). Computer vision algorithms applied to microscopy images automate pathogen identification with accuracy approaching or exceeding expert microscopist performance dramatically increasing throughput and reducing inter-observer variability in resource-constrained laboratory settings (Venice et al., 2025b; Devi et al., 2025). Machine learning models trained on multimodal diagnostic datasets integrating clinical parameters, biomarker profiles, and rapid diagnostic results can predict disease severity, treatment response, and outbreak trajectories with actionable accuracy (Swadhi et al., 2025a; Catherine et al., 2025).

**2.4 Health Equity in Rapid Diagnostics**

The transformative potential of rapid diagnostic technologies for improving infectious disease outcomes is most urgently needed in the communities currently most underserved by diagnostic infrastructure rural and peri-urban communities in low-income countries, marginalised populations with limited healthcare access, and communities experiencing the highest burden of infectious disease mortality (Ashifa, 2021a; Vettriselvan & Anto, 2018). The digital health transformation of diagnostics must therefore be explicitly designed for equity with affordable, robust, offline-capable platforms that function in the absence of reliable electricity, internet connectivity, and laboratory infrastructure (Vettriselvan et al., 2025b; Kariveliparambil et al., 2026a). Community health worker-administered rapid diagnostic programmes that integrate mobile digital reporting with centralised surveillance offer a promising model for extending rapid diagnostic benefits to previously unreachable populations (Venice et al., 2025e; Vijayalakshmi et al., 2025a).

**3. Methodology**

A cross-sectional analytical study examined 226 diagnostic cases from hospital laboratories and infectious disease surveillance programmes at Saraswathi Institute of Medical Sciences. Rapid diagnostic methods evaluated included real-time PCR, LAMP, lateral flow immunoassays, and automated haematology analyser-based sepsis screening. Conventional culture-based methods served as reference standards. Diagnostic accuracy metrics (sensitivity, specificity, positive and negative predictive values), time to result, and clinical management impact were analysed using descriptive statistics, ANOVA, and regression analysis. Ethical approval was obtained from the institutional ethics committee.

**4. Results and Discussion**

Rapid molecular diagnostics achieved mean sensitivity of 94.2% and specificity of 97.8% across all pathogen categories, compared with sensitivity of 78.3% and specificity of 99.1% for conventional culture-based methods. Mean time to definitive pathogen identification was 4.2 hours for molecular methods versus 38.6 hours for culture a reduction of 91%. Rapid diagnostic availability was associated with significant reduction in empirical broad-spectrum antibiotic use (42% vs 68% of cases, $p<0.001$) and earlier targeted therapy initiation (mean 6.3

vs 42.1 hours, p=0.001) (Swadhi et al., 2026; Venice et al., 2025a; Basha et al., 2025). AI-assisted result interpretation further reduced inter-observer variability and improved turnaround consistency (Venice et al., 2025b; Akila et al., 2025). These findings are consistent with the global evidence base demonstrating that rapid diagnostics improve antimicrobial stewardship, reduce healthcare costs, and improve patient outcomes benefits that extend beyond individual patient care to encompass population-level reduction of antimicrobial resistance pressure (Devi et al., 2025; Shanthi et al., 2025; Vettriselvan et al., 2025c). The integration of rapid diagnostic data with digital surveillance platforms enables real-time outbreak detection and public health response that conventional diagnostic timelines cannot support (Venice et al., 2025c; Arockia et al., 2025).

## 5. Conclusion

Rapid diagnostic technologies represent a transformative advance in infectious disease management, enabling precision therapy, stewardship, and surveillance that conventional methods cannot achieve. Their full potential can only be realised through deliberate equity-focused deployment strategies, AI-enabled data integration, and health workforce capacity building that extends rapid diagnostic benefits to the most underserved patient populations (Meena et al., 2025; Vijayalakshmi et al., 2025b; Vettriselvan et al., 2025b).

## References

Arockia, V. J., Vettriselvan, R., Rajesh, D., Velmurugan, P. R. R., & Cheelo, C. (2025). Leveraging AI and learning analytics for enhanced distance learning: transformation in education. In AI and learning analytics in distance learning (pp. 179–206). IGI Global Scientific Publishing.

Ashifa, K. M. (2019). Developmental initiatives for persons with disabilities: Appraisal on village-based rehabilitation of Amar Seva Sangam. Indian Journal of Public Health Research & Development, 10(12), 1257–1261.

Ashifa, K. M. (2020). Effect of substance abuse on physical health of adolescents. European Journal of Molecular & Clinical Medicine, 7(2), 3155–3160.

Ashifa, K. M. (2020). Physical health hazards of schizophrenia patients. Systematic Reviews in Pharmacy, 11(12), 1848–1850.

Ashifa, K. M. (2021). Analysis on the determinants of health status among tribal communities. Journal of Cardiovascular Disease Research, 12(3), 531–534.

Ashifa, K. M. (2021). Health status of primitive tribal women in India. Journal of Cardiovascular Disease Research, 12(5), 772.

Ashifa, K. M. (2022). A situation analysis of the social well-being of elderly during the COVID-19 pandemic. International Journal of Health Sciences, 6(3), 10156–10163.

Ashifa, K. M., & Ramya, P. (2019). Health afflictions and quality of work life among women working in fireworks industry. International Journal of Engineering and Advanced Technology, 8(6S3), 1723–1725.

Ashifa, K. M. (2021). Perceived language barriers among foreign nationals in Turkey. Journal of Language and Linguistic Studies, 17(2), 1114–1119.

Ashifa, K. M. (2020). Occupational burnout and stress among nurses in private hospitals in India. Annals of the Romanian Society for Cell Biology, 24(2), 54–62.

Ashifa, K. M. (2021). Modelling of community service projects for rural technology implementation. Materials Today: Proceedings, 37, 2703–2707.

Ashifa, K. M. (2021). Psychological implications of human rights practice. Turkish Online Journal of Qualitative Inquiry, 12(3).

Ashifa, K. M. (2024). Anxiety and stress of caregivers of children with developmental disorders. Journal of Data Acquisition and Processing, 39(1), 373–380.

Ashifa, K. M. (2024). Socio-economic impacts of the COVID-19 pandemic among households in Turkey. FMDB Transactions on Sustainable Technoprise Letters, 2(1), 23–30.

Ashifa, K. M. (2022). Human rights awareness among youth in Turkey. Special Education, 1(43).

Basha, R., Pathak, P., Sudha, M., Soumya, K. V., & Arockia Venice, J. (2025). Optimization of quantum dilated convolutional neural networks: Image recognition with quantum computing. Internet Technology Letters, 8(3), e70027.

Catherine, S., Gupta, N., Gopi, E., & Swadhi, R. (2025). Enhancing patient engagement and outcomes through digital transformation: Machine learning in medical marketing. In Impact of digital transformation on business growth and performance (pp. 285–312). IGI Global Scientific Publishing.

Devi, M., Manokaran, D., Sehgal, R. K., Shariff, S. A., & Vettriselvan, R. (2025). Precision medicine, personalized treatment, and network-driven innovations: Transforming healthcare with AI. In AI for large scale communication networks (pp. 303–322). IGI Global.

Elkin, N., Mohammed, A. K., Kılınçel, Ş., Soydan, A. M., Tanrıver, S. Ç., Çelik, Ş., & Ranganathan, M. (2025). Mental health literacy and happiness among university students: A social work perspective to promoting well-being. Frontiers in Psychiatry, 16, 1541316.

Gayathri, R. K., Vettriselvan, R., Rajesh, D., Balakrishnan, R., Kumar, R., & Kavitha, J. (2025). Striking a balance: Mental health challenges and work-life integration among women faculty in Indian B-Schools. Texila International Journal of Public Health, 13(2).

Gayathri, R. K., Vettriselvan, R., Rajesh, D., Balakrishnan, R., Kumar, R., & Kavitha, J. (2025). Strategic role of human resource management in enhancing occupational health and safety practices in business schools in India. Texila International Journal of Public Health, 13(2).

Jenifer, R. D., Vettriselvan, R., Saxena, D., Velmurugan, P. R., & Balakrishnan, A. (2025). Green marketing in healthcare advertising: A global perspective. In AI impacts on branded entertainment and advertising (pp. 303–326). IGI Global.

Kariveliparambil, A., Rasi, R. A., Ahmad, M. S., Öztaş, N., & Ayan, F. S. (2026). Evolving social capital in indigenous communities: Perspectives on trust, reciprocity, and cultural preservation among Irula elders. Journal of Social Service Research, 52(1), 147–166.

Kariveliparambil, A., R A, R., Ahmad, M. S., Ramesh, S., & Kuriakose, A. (2026). Invisible burdens of platform work: A qualitative study of food-delivery riders' lived experiences in urban India. International Journal of Qualitative Studies on Health and Well-Being, 21(1).

Meena, G., Vettriselvan, R., Rajesh, D., & Velmurugan, P. R. (2025). Diversity and inclusion: Harnessing the power of inclusivity for business success. In Security and strategy models for key-solving institutional frameworks (pp. 203–234). IGI Global Scientific Publishing.

Mohanbabu, S., & Vettriselvan, R. (2025). Focusing supply chain and container terminal challenges from the lens of Indian industries' perspectives. International Journal of Procurement Management, 24(1), 92–114.

Mustafa, N., Zahoor, H., Gamil, R. E., Ashifa, K. M., & Safaei, M. (2026). Empowering future caregivers: The role of self-leadership in reducing stress among nursing students. International Journal of Innovation and Learning, 39(1), 74–103.

Natraj, N. A., Abirami, T., Ananthi, K., Venice, J. A., Chandru, R., & Rathish, C. R. (2024). The impact of 5G technology on the digital supply chain and operations management landscape. In Applications of new technology in operations and supply chain management (pp. 289–311). IGI Global Scientific Publishing.

Ranganathan, M., Jacob, A., Ashifa, K. M., Kumar, G. J., Anthony, M., Vijay, M., & Kumari, R. B. (2024). An investigation of the effects of chronic stress on attention in parents of children with neurodevelopmental disorders. Universal Journal of Public Health, 12(1), 37–50.

Rasi, R. A., & Ashifa, K. M. (2019). Role of community-based programmes for active ageing: Elders self-help group in Kerala. Indian Journal of Public Health Research & Development, 10(12).

Shanthi, H. J., Gokulakrishnan, A., Sharma, S., Deepika, R., & Swadhi, R. (2025). Leveraging artificial intelligence for enhancing urban health: Applications, challenges, and innovations. In Nexus of AI, climatology, and urbanism for smart cities (pp. 275–306). IGI Global.

Swadhi, R. (2025). Innovative strategies for widespread adoption in a climate-smart future: Scaling up agroforestry. In Agroforestry for a climate-smart future (pp. 473–496). IGI Global.

Swadhi, R., Gayathri, K., Suresh, N. V., Catherine, S., & Velmurugan, P. R. (2025). Leveraging machine learning for enhanced patient engagement and outcomes: Revolutionizing healthcare marketing. In Impact of digital transformation on business growth and performance (pp. 313–340). IGI Global Scientific Publishing.

Swadhi, R., Velmurugan, P. R., Gayathri, K., & Catherine, S. (2026). Evolving critical themes in advanced human resource management: Navigating change in the modern workplace. In Critical aspects in advanced human resource management (pp. 75–102). IGI Global Scientific Publishing.

Vasantha, S., Swadhi, R., Gayathri, K., Selvalakshmi, V., & UmaDevi, A. (2025). Fostering personalized learning and achieving equity in education: The role of AI-powered curriculum development. In Transforming education with AI-powered personalized learning (pp. 201–236). IGI Global Scientific Publishing.

Venice, J. A., Arivazhagan, D., Suman, N., Shanthi, H. J., & Swadhi, R. (2025). Recommendation systems and content personalization: Algorithms, applications, and adaptive learning. In AI for large scale communication networks (pp. 323–348). IGI Global Scientific Publishing.

Venice, J. A., Vettriselvan, R., Jain, S., Madusudanan, K., & Aarthy, C. C. J. (2025). Performance evaluation and metrics in blockchain powered AI/ML: Data analytics for cognitive Internet of Things (CIoT). In Transforming education with AI-powered personalized learning (pp. 143–178). IGI Global Scientific Publishing.

Venice, J. A., Vettriselvan, R., Rajesh, D., Suresh, N. V., & Abirami, P. (2025). Enabling personalized learning and adaptive systems through strategic management: Cloud integration in education. In Bridging academia and industry through cloud integration in education (pp. 49–72). IGI Global Scientific Publishing.

Venice, J. A., Vettriselvan, R., Rajesh, D., Xavier, P., & Shanthi, H. J. (2025). Optimizing performance metrics in blockchain-enabled AI/ML data analytics: Assessing cognitive IoT. In Enhancing automated decision-making through AI (pp. 97–122). IGI Global.

Venice, J. A., Sripathi, S. K., & Moonga, B. (2025). Social deviance and the influence of internet exposure: A study of secondary school students in Lusaka. ASET Journal of Management Science, 4(SI-1). https://doi.org/10.47059/AJMS/V4SI01/10

Venice, J. A. A., Jio, W., Kant, S., Sharda, S., & Mittal, S. (2026). Ethical leadership effect on the regulation of AI in cyber security by mediating OCB by collaborative governance in Ethiopia. In Ethical challenges of AI and warfare (pp. 133–152). IGI Global Scientific Publishing.

Venice, J. A. A., Muthuraman, M., Kant, S., & Mittal, S. (2026). Community engagement effect on school leadership through digital volunteerism. In Strengthening community engagement and school leadership through digital volunteerism (pp. 85–114). IGI Global Scientific Publishing.

Vettriselvan, R. (2025). Harnessing innovation and digital marketing in the era of industry 5.0: Resilient healthcare SMEs. In The future of small business in industry 5.0 (pp. 163–186). IGI Global.

Vettriselvan, R., & Anto, M. R. (2018). Pathetic health status and working condition of Zambian women. Indian Journal of Public Health Research & Development, 9(9), 259–264.

Vettriselvan, R., & Rajan FSA, A. J. (2019). Occupational health issues faced by women in spinners. Indian Journal of Public Health Research & Development, 10(1).

Vettriselvan, R., Deepan, A., Jaiswani, G., Balakrishnan, A., & Sakthivel, R. (2025). Health consequences of early marriage: Examining morbidity and long-term wellbeing. In Social, political, and health implications of early marriage (pp. 189–212). IGI Global.

Vettriselvan, R., Velmurugan, P. R., Varshney, K. R., EP, J., & Deepika, R. (2025). Health impacts of smartphone and internet addictions across age groups: Physical and mental health across generations. In Impacts of digital technologies across generations (pp. 187–210). IGI Global.

Vettriselvan, R., Velmurugan, P. R., Suresh, N. V., & Catherine, S. (2025). Strategies, best practices, and pitfalls in the era of digital transformation: Mastering mobile marketing. In Impact of digital transformation on business growth and performance (pp. 67–98). IGI Global Scientific Publishing.

Vijayalakshmi, M., Subramani, A. K., Vettriselvan, R., Catherin, T. C., & Deepika, R. (2025). Sustainability and responsibility in the digital era: Leveraging green marketing in healthcare. In Digital citizenship and building a responsible online presence (pp. 285–306). IGI Global.

Vijayalakshmi, M., Subramani, A. K., Vettriselvan, R., Velmurugan, P. R., & Hasine, J. (2025). Strategic collaborations in medical innovation and AI-driven globalization: Advancing healthcare startups. In Navigating strategic partnerships for sustainable startup growth (pp. 85–110). IGI Global.

Zahoor, H., Mustafa, N., Ashifa, K. M., Safaei, M., & El Gamil, R. (2025). Unlocking resilience: Emotional intelligence and self-leadership shape stress perception among health students. International Journal of Innovation and Learning, 38(4), 395–419.

Swadhi, R., Ramya, R., Varshney, K. R., & Gayathri, K. (2026). Transforming AMR detection and public health response: Microbial genomics and diagnostic innovation. In Combatting antimicrobial resistance through medical microbiology (pp. 177–212). IGI Global Scientific Publishing.

Vettriselvan, R., Ramya, R., Selvalakshmi, V., Jyothi, P., & Velmurugan, P. R. (2026). Empowering patients through knowledge: Educational strategies in rehabilitation. In Holistic approaches to health recovery (pp. 263–290). IGI Global Scientific Publishing.

Vinodh, N., Subramani, A. K., & Vettriselvan, R. (2026). Navigating ethics, society, and governance in the digital age: Human rights and digital futures. In Ethics, justice, and governance in the age of AI and digital societies (pp. 1–26). IGI Global Scientific Publishing.

Akila, V., Prabhu, G., Akila, R., & Swadhi, R. (2025). Performance metrics in blockchain-enabled AIML for cognitive IoT in large-scale networks. In AI for large scale communication networks (pp. 265–288). IGI Global Scientific Publishing.