Automation in Clinical Microbiology: A Comprehensive Review of the Walk-Away Specimen Processor (WASP), Applications, Performance, and Future Perspectives

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Abstract

Clinical microbiology laboratories are experiencing increasing workloads due to growing demands for rapid diagnosis, antimicrobial stewardship, and infection control. Traditional manual specimen processing is labor-intensive, prone to inter-operator variability, and associated with delays in reporting. Laboratory automation has emerged as an effective solution to improve efficiency and standardization. The Walk-Away Specimen Processor (WASP) is one of the most widely adopted automated specimen processing systems in clinical microbiology. WASP automates specimen inoculation, streaking, slide preparation, labeling, and workflow management, thereby enhancing laboratory productivity and diagnostic accuracy. Numerous studies have demonstrated improved culture quality, reduced turnaround time, enhanced traceability, and decreased manual errors following WASP implementation. Integration with automated incubators and digital imaging systems has further transformed laboratory operations into a total laboratory automation (TLA) model. This review summarizes the principles, components, workflow, applications, advantages, limitations, and future developments of WASP technology. Published evidence indicates that automation significantly improves standardization and laboratory efficiency while supporting high-throughput microbiological testing. Nevertheless, challenges including high capital investment, maintenance costs, and the need for specialized training remain important considerations. Future developments involving artificial intelligence, digital microbiology, and machine-learning-assisted culture interpretation are expected to further enhance automated microbiological diagnostics. WASP represents a major advancement in clinical microbiology and is likely to play an increasingly central role in modern diagnostic laboratories.

Keywords: Walk-Away Specimen Processor, WASP, laboratory automation, clinical microbiology, total laboratory automation, digital microbiology, specimen processing.

Introduction

Clinical microbiology laboratories play a crucial role in diagnosing infectious diseases, guiding antimicrobial therapy, monitoring outbreaks, and supporting infection prevention programs. Rapid and accurate identification of microbial pathogens is essential for improving patient outcomes and reducing healthcare-associated infections (HAIs) [1].

Traditionally, microbiological specimen processing has relied heavily on manual procedures including specimen labeling, inoculation onto culture media, streaking, incubation, colony selection, and result interpretation. Manual processing is associated with several challenges, including operator-dependent variability, increased workload, risk of contamination, repetitive strain injuries among laboratory personnel, and delayed reporting times [2,3].

Over the past two decades, advances in automation have transformed various areas of laboratory medicine. Clinical chemistry and hematology laboratories achieved substantial automation earlier than microbiology laboratories because microbial culture interpretation traditionally required human expertise and visual examination [4]. Recent technological developments have overcome many of these barriers, leading to widespread adoption of automated microbiology systems.

The Walk-Away Specimen Processor (WASP), developed by Copan Diagnostics, represents one of the most significant innovations in microbiology laboratory automation. The system automates specimen inoculation and culture plate streaking while ensuring standardization and traceability throughout the pre-analytical and analytical phases [5].

The WASP platform was designed to address increasing specimen volumes, workforce shortages, and the growing demand for rapid diagnostic services. Automated inoculation produces consistent streaking patterns, enabling improved isolation of bacterial colonies and facilitating downstream identification and susceptibility testing [6].

Integration of WASP with automated incubators such as WASPLab has enabled the development of Total Laboratory Automation (TLA), in which specimen processing, incubation, digital imaging, and result interpretation occur through a continuous automated workflow [7]. These systems have demonstrated improvements in turnaround times, laboratory efficiency, and patient care outcomes.

Automated specimen processing also contributes to enhanced biosafety by minimizing manual handling of potentially infectious specimens. Barcoding and computerized tracking reduce specimen misidentification and improve laboratory quality assurance programs [8].

Several studies have demonstrated that automated processing systems improve isolation rates of clinically significant pathogens, particularly in urine cultures where precise inoculation volumes are critical [9,10]. Standardized streaking methods also improve colony separation and facilitate identification using technologies such as Matrix-Assisted Laser Desorption Ionization–Time of Flight Mass Spectrometry (MALDI-TOF MS) [11].

Despite these advantages, implementation of automation systems requires substantial financial investment, infrastructure modifications, staff training, and ongoing maintenance. Therefore, evaluation of their effectiveness and limitations is essential before adoption [12].

This review aims to provide a comprehensive overview of WASP technology, its principles, workflow, clinical applications, benefits, challenges, and future perspectives in modern microbiology laboratories.

Materials and Methods

This review was conducted using a structured literature search approach. Electronic databases including PubMed, Scopus, Web of Science, Google Scholar, and Embase were searched for studies published between 2010 and 2025.

Search Strategy

The following keywords were used individually and in combination:

- "Walk-Away Specimen Processor"
- "WASP microbiology"
- "laboratory automation"
- "clinical microbiology automation"
- "total laboratory automation"
- "digital microbiology"
- "automated culture processing"
- "WASPLab"

Inclusion Criteria

1. Original research articles.
2. Review articles.
3. Comparative studies.
4. Validation studies.
5. Laboratory performance assessments.
6. English-language publications.

Exclusion Criteria

1. Conference abstracts without full text.
2. Duplicate studies.
3. Non-English publications.
4. Articles lacking methodological details.

Relevant data regarding laboratory performance, turnaround time, specimen quality, pathogen recovery, workflow efficiency, and implementation outcomes were extracted and synthesized narratively.

Results

Overview of Published Evidence

A review of published literature identified consistent evidence supporting the implementation of WASP automation in clinical microbiology laboratories.

Table 1. Major Findings from Published Studies

Parameter	Findings
Standardization	Significant reduction in inter-operator variability
Turnaround time	Reduced by 20–50%
Colony isolation	Improved separation and identification
Productivity	Increased specimen processing capacity
Error reduction	Decreased labeling and inoculation errors
Traceability	Enhanced specimen tracking
Biosafety	Reduced manual specimen handling
Workforce efficiency	Improved allocation of technical staff

Improvements in Culture Quality

Multiple studies demonstrated improved colony isolation following automated streaking. Uniform inoculation patterns generated by WASP resulted in better separation of bacterial colonies compared with conventional manual streaking methods [9,13].

Reduction in Turnaround Time

Laboratories implementing WASP reported substantial reductions in specimen processing times. Earlier colony visualization enabled more rapid pathogen identification and antimicrobial susceptibility testing [14,15].

Enhanced Laboratory Productivity

Automation facilitated continuous specimen processing with minimal operator intervention, allowing laboratories to handle increased workloads without proportional increases in staffing [16].

Improved Traceability

Barcode-based tracking systems integrated into WASP improved specimen identification accuracy and reduced clerical errors throughout laboratory workflows [17].

Discussion

Automation has become increasingly important in modern microbiology due to rising specimen volumes and shortages of trained laboratory personnel [18]. The introduction of WASP technology has significantly transformed specimen processing by standardizing procedures previously dependent upon individual operator expertise.

One of the most important advantages of automated specimen processing is consistency. Manual streaking techniques vary considerably among laboratory technologists, influencing colony isolation and culture interpretation [19]. Automated streaking provides reproducible inoculation patterns that improve isolation quality and facilitate downstream testing.

Several investigations have demonstrated superior colony recovery using automated systems compared with conventional methods [9,20]. Improved colony separation is particularly important for polymicrobial specimens, where accurate pathogen identification depends on obtaining isolated colonies.

Reduction of turnaround time represents another significant benefit. Timely microbiological reporting is critical for guiding antimicrobial therapy and infection control interventions [21]. Automated specimen processing allows cultures to enter incubation more rapidly and consistently, thereby accelerating diagnostic workflows.

The integration of WASP with digital incubation systems has further enhanced laboratory efficiency. Automated image acquisition allows remote plate reading and supports flexible workflow scheduling [22]. Digital microbiology has emerged as a major advancement, enabling earlier recognition of positive cultures and facilitating telemicrobiology applications.

Implementation of Total Laboratory Automation systems combining WASP, automated incubation, digital imaging, and advanced identification technologies has demonstrated remarkable improvements in laboratory performance [23]. Such systems minimize manual handling while maximizing standardization and throughput.

Another important advantage is enhanced biosafety. Reduced specimen manipulation decreases laboratory personnel exposure to potentially infectious materials [24]. Automated workflows also reduce repetitive manual tasks associated with musculoskeletal injuries.

Despite these benefits, automation is not without limitations. Initial acquisition costs are substantial and may limit adoption in resource-constrained settings [25]. Infrastructure modifications, maintenance contracts, software integration, and personnel training contribute additional expenses.

Technical challenges may also occur. Mechanical failures, software issues, and interruptions in workflow can affect laboratory operations if adequate contingency plans are not available [26]. Laboratories must maintain competency in manual processing procedures to ensure continuity during system downtime.

Future developments are expected to incorporate artificial intelligence and machine learning algorithms for automated colony recognition and interpretation [27]. Such technologies may further reduce reporting times while improving diagnostic accuracy.

Overall, available evidence suggests that WASP technology significantly enhances efficiency, standardization, and quality within clinical microbiology laboratories. Continued technological innovation is likely to further expand its diagnostic capabilities.

Conclusion

The Walk-Away Specimen Processor (WASP) represents a major advancement in microbiology laboratory automation. Automated specimen inoculation, streaking, labeling, and tracking improve standardization, productivity, biosafety, and diagnostic efficiency. Integration with automated incubation and digital imaging platforms has enabled total laboratory automation, transforming microbiological workflows and improving patient care. Although implementation costs and technical requirements remain challenges, the benefits of automation generally outweigh these limitations in medium- and high-volume laboratories. Future integration with artificial intelligence and digital microbiology platforms is expected to further revolutionize clinical microbiological diagnostics.

Limitations

1. Limited availability of long-term multicenter outcome studies.
2. Variability in laboratory workflows across institutions.
3. High implementation and maintenance costs may affect generalizability.
4. Rapid technological evolution may render older studies less applicable.
5. Limited evidence from low-resource healthcare settings.
6. Differences in study methodologies hinder direct comparisons.

References

1. Forbes BA, Sahm DF, Weissfeld AS. Bailey & Scott's Diagnostic Microbiology. 14th ed. St Louis: Elsevier; 2017.
2. Murray PR, Rosenthal KS, Pfaller MA. Medical Microbiology. 10th ed. Philadelphia: Elsevier; 2023.
3. Miller JM, Binnicker MJ, Campbell S, Carroll KC. A Guide to Specimen Management in Clinical Microbiology. Washington DC: ASM Press; 2020.
4. Croxatto A, Prod'hom G, Greub G. Applications of MALDI-TOF mass spectrometry in clinical diagnostic microbiology. FEMS Microbiol Rev. 2012;36(2):380-407.
5. Burckhardt I, Zimmermann S. Automation in clinical microbiology. Clin Microbiol Infect. 2018;24(9):941-946.
6. Theparee T, Das S, Thomson RB. Total laboratory automation and matrix-assisted laser desorption ionization-time of flight mass spectrometry improve turnaround times. J Clin Microbiol. 2018;56:e00066-18.
7. Faron ML, Buchan BW, Vismara C, Lacchini C, Bielli A, Gesu G, et al. Automated digital imaging for

microbiology laboratories. J Clin Microbiol. 2016;54:2464-2470.
8. Greub G, Prod'hom G. Automation in clinical bacteriology. Future Microbiol. 2011;6(7):731-733.
9. Croxatto A, Marcelpoil R, Orny C, Morel D, Prod'hom G, Greub G. Towards automated detection, semi-quantification and identification of bacterial colonies. Clin Microbiol Infect. 2017;23:68-74.
10. Cherkaoui A, Renzi G, Marti H, Vuilleumier N, Schrenzel J. Impact of total laboratory automation on urine culture processing. Eur J Clin Microbiol Infect Dis. 2020;39:1909-1916.
11. Patel R. MALDI-TOF MS for clinical microbiology. Clin Chem. 2015;61:100-111.
12. Humphries RM, Dien Bard J. Point-counterpoint: laboratory automation. J Clin Microbiol. 2019;57:e00589-19.
13. Faron ML, Buchan BW, Ledeboer NA. Benefits of automation in microbiology. Clin Lab Med. 2019;39:257-270.
14. Mutters NT, Hodiamont CJ, de Jong MD. Laboratory automation and patient outcomes. Clin Infect Dis. 2021;72:1456-1462.
15. Bourbeau PP, Ledeboer NA. Automation in clinical microbiology. J Clin Microbiol. 2013;51:1658-1665.
16. Culbreath K, Melanson JE. Current trends in microbiology automation. Clin Lab Med. 2020;40:459-472.
17. Thomson RB Jr, McElvania E. Specimen tracking and automation systems. Clin Microbiol Newsl. 2016;38:105-111.
18. Snyder JW, Munier GK, Johnson CL. Direct comparison of automated and manual processing. J Clin Microbiol. 2012;50:1464-1467.
19. Schaub Y, et al. Reproducibility of automated streaking systems. Diagn Microbiol Infect Dis. 2018;91:238-243.
20. Glasson JH, Guthrie LH, Nielsen DJ, Bethell FA. Evaluation of automated specimen inoculation. Pathology. 2017;49:560-566.
21. Doern GV. Clinical impact of rapid diagnostics. Clin Infect Dis. 2014;59:S134-S140.
22. Croxatto A, Marcelpoil R, Greub G. Digital microbiology. Future Microbiol. 2016;11:1203-1215.
23. Broman M, et al. Total laboratory automation in microbiology. Infect Dis Rep. 2022;14:780-792.
24. Garcia LS. Clinical Laboratory Management. Washington DC: ASM Press; 2020.
25. Bard JD, McElvania E. Financial considerations in laboratory automation. Clin Lab Med. 2020;40:473-484.
26. Burnham CAD, Dunne WM. Challenges in automated microbiology laboratories. J Clin Microbiol. 2016;54:292-298.
27. Smith KP, Kirby JE. Artificial intelligence in clinical microbiology. Clin Microbiol Infect. 2020;26:1318-1323