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Total automation in clinical bacteriology: technology at the service of the patient

Total laboratory automation in clinical bacteriology: a technology to improve patient care



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To the time when analytical procedures in clinical bacteriology become more complex and costs continue to increase, the total automation of microbial cultures (*Total Laboratory Automation*, TLA) cannot come down to a simple transposition of traditional procedures. On the other hand, automation should lead to a fundamental change in laboratory workflows and induce users to fundamentally reconsider all approaches used in clinical diagnosis, including accurate identification of pathogens and methods of testing for susceptibility to antimicrobial agents.

The beginning of the 19th$_{e}$century saw the development of the industrial revolution. Improving production performance – and ultimately process automation – has been a constant motivation in industrial development, mainly for cost issues, but also for worker safety. During theXX$_{e}$century, the electronic revolution enabled automation to alleviate physically difficult, tedious or routine handling tasks. Automation then appeared as the way to improve business productivity.
Reduced operating costs, improved product or service availability, increased production reliability are typical benefits expected from an automation process. However, despite a broad consensus on these benefits, there are a number of hurdles that need to be overcome before implementing automation, and this is true across different business domains. As automation projects take shape, several questions regarding its acceptance by workers and their relationship to machines have widely emerged. Many workers view robotization as a direct threat to their jobs. Therefore,

Clinical bacteriology has always been a highly manual discipline and laborious and, unlike clinical biochemistry, immunology and hematology, the total automation of culture processes is much more complex due to the great heterogeneity of clinical samples, the types of containers used for the transport of specimens and the complexity of the analytical procedures.

Today, all clinical diagnostic laboratories are faced with increasing demands for quality improvement, productivity, turnaround time reduction and result reporting (TAT,*turn around time*) to reduce the misuse of antibiotics. The rationalization of the workforce is also a parameter to be taken into account. Meeting these growing needs requires very effective strategies. In this sense, TLA represents an attractive option given that most of the workload in clinical bacteriology is based on sample handling, inoculation on different culture media

solids and liquids, incubation, culture reading, pathogen identification and antimicrobial susceptibility testing. All of these steps are highly manual processes.

The implementation of the TLA (Copan WASPLab®) in the bacteriology laboratory of the University Hospitals of Geneva (Switzerland) has been segmented into different packages (segmentation based on the type of samples to be analyzed) allowing the sequential validation of the processes, the staff training and routine implementation. Such a process has enabled us to achieve 90% of "automated" samples in one year, including staff training, documentation for accreditation supported by publications, and this, without ever interrupting routine operations. In addition, we have implemented a fully automated solution for antibiograms by diffusion in agar medium (Copan Colibrí™ + Radian®)*[1]*. Structured supervision and precise monitoring of all activities related to the automation project, including key partners such as IT support, technical service and after-sales service, enabled us to meet project deadlines and 'significantly improve workflows***(picture)***.

Approximately 30,000 urine samples per year are analyzed in our laboratory. Using TLA, the median TAT for negative reports decreased by almost half, from 52.1 to 28.3 h ($p < 0.001$), potentially allowing unnecessary antimicrobial treatments to be stopped 1 day sooner. Importantly, this reduction in TAT was not associated with a loss of analytical sensitivity. On the contrary,

Optimized urine samples and higher incubation periods for fastidious uropathogens *cus*spp.*[2]*.

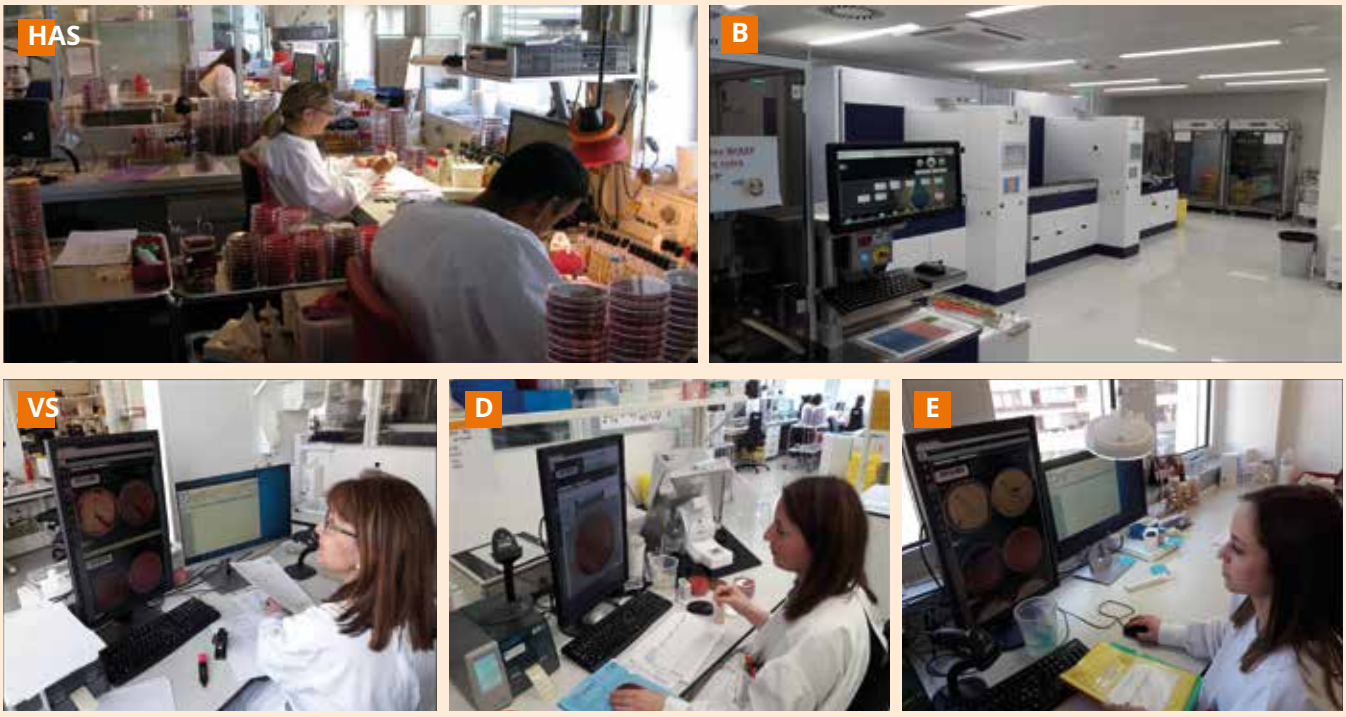


Fig.Analytical procedures in clinical bacteriology: conventional versus TLA.(HAS)The bacteriology laboratory of the University Hospitals of Geneva (Switzerland) before the TLA.(B)The new laboratory after the installation of the TLA.(THIS)Part of the workstations linked to the TLA (different generations of technicians analyzing the photos of the crops). To date, 97% of samples are analyzed by the TLA. The remaining 3% correspond to certain specific samples (such as prostheses, catheters, drains).

1. Cherkaoui A et al. Performance of fully automated antimicrobial disk diffusion susceptibility testing using Copan WASP Colibri coupled with the Radian in-line carousel and expert system. J Clin Microbiol 2021;59(9):e0077721.

2. Cherkaoui A, Schrenzel J. Total laboratory automation for rapid detection and identification of microorganisms and their antimicrobial resistance profiles. Front Cell Infect Microbiol 2022;12:807668.

3. Cherkaoui A et al. Impact of total laboratory automation on turnaround times for urine cultures and screening specimens for MRSA, ESBL, and VRE carriage: retrospective comparison with manual workflow. Front Cell Infect Microbiol 2020;10:552122.

4. The European Committee on Antimicrobial Susceptibility Testing. Rapid AST directly from blood culture bottles. 2022. https://www.eucast.org/rapid_ast_in_blood_cultures/

To cope with the continuous increase in antimicrobial resistance and its dramatic consequences, infection control has become one of the central activities of clinical bacteriology laboratories. The quantity of screening samples for carbapenemase-producing Enterobacteriaceae, extended-spectrum β-lactamases (ESBL), *Staphylococcus aureus* methicillin-resistant (MRSA) and vancomycin-resistant (VRE) enterococci sent to bacteriology laboratories for analysis has increased dramatically over the past decade. In our laboratory, we process approximately 35,000 screening samples per year. Using TLA, the median TAT for negative reports decreased by almost half for MRSA screening, from 50.7 to 26.3 h ($p < 0.001$). The difference in median TAT for negative cultures was less pronounced for screening for ESBL (50.2 versus 43.0 h; $p < 0.001$) and VRE (50.6 versus 45.7 h; $p < 0.001$), but remained significant *[3]*.

The TLA has demonstrated its ability to adapt to the wide variety of samples and the complexity of procedures. Its positive impact on various parameters (quality of results, productivity, traceability and improvement of TATs) has also been carefully evaluated and published. These advantages have recently been reinforced by the complete automation of diffusion antibiograms. Implementing artificial intelligence (AI) to quickly identify bacterial growth (detection), but also to differentiate bacterial morphologies (segmentation) and enumerate corresponding colonies (counting) will further improve workflow and ensure reproducible performance and predictable. Validation studies are now warranted to allow automatic processing of negative cultures using AI and automatic 24/7 dissemination of results to clinicians without human intervention. Finally, the TLA using the Copan Radian® module allows the realization without constraint, and with a better reliability of the results, of the rapid antibiograms from the positive blood cultures according to the RAST protocol. *(Rapid Antimicrobial Susceptibility Testing)* published by EUCAST *[4]*.

A. Cherkaoui declares that he has no conflict of interest in relation with this article.

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