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Editorial

Laboratory Automation in Clinical Microbiology: A Quiet Revolution

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The field of infectious diseases is faced with drastic changes – emergence of multidrug-resistant organisms (MDROs), increase of international travel and therefore easier spread of infectious agents between continents, new challenges due to demographic change, and finally climate change.

Dr. William H. Stewart, the US Surgeon General during 1965–1969, said: "It is time to close the book on infectious diseases, and declare the war against pestilence won" [1]. Now, in the year 2014, we have to say that he could not have been more wrong and rarely a statement was refuted as quickly as this. The burden of infectious diseases is still very high and great amounts of morbidity and mortality worldwide are caused by infections.

Due to international travel pathogens can cross international borders with ease [2]. This can lead to the introduction of pathogens or resistance genes in previously unaffected regions or populations [3]. This might also influence the growing prevalence rates of MDROs which have been detected all over the world, especially in Gram-negatives [4]. Infections with MDROs usually have higher mortality rates mainly due to the obviously higher risk of treatment failure and ineffective initial antimicrobial therapy. Other consequences of infections with MDROs are increased costs of antibiotic therapy, significant increased length of stay (LOS), and isolation costs. The most important factor fuelling the MDROs epidemic is the extensive use of broad-spectrum antibiotics which triggers the proliferation of highly resistant organisms. As a response to the increasing problem of antibiotic resistance multiple antibiotic stewardship programs have been developed mainly aiming to enforce de-escalation strategies and reduce the consumption of antimicrobial substances; hence reducing the selection pressure and subsequently the spread of MDROs as well. For all this measures to be applied, however, rapid microbiological testing is necessary. Despite manifold improvements in conventional methods (CM) the time that elapses until reporting the final result remains a limiting factor. Without fast microbiological diagnostics, however, strategies such as de-escalation of initial antibiotic therapy will not be very efficient. Most clinical microbiology laboratories are still largely based on CM for routine identification of pathogens, such as Gram staining, culture of clinical specimens, phenotypic susceptibility testing and biochemical or genotypic identification. Regardless of the degree of efficiency of individual laboratories routine microbiological diagnostic with CM currently takes about 48-72 hours until completion. This time is too long to react quickly and properly. The delay can result in incorrect antibiotic therapy, prevents early targeted antibiotic therapy and promotes a possible nosocomial transmission of pathogens as well as the further development of resistance. Already in 1994, Doern and colleagues showed that with a partial acceleration of CM, LOS can be shortened and antibiotic consumption decreased [5].

Nevertheless, only recently the times are changing in clinical microbiology and a quiet revolution is about to take place. While automated systems are not new to clinical chemistry and clinical haematology laboratories, clinical microbiology laboratories have largely been excluded from this trend so far [6]. Automation, however, offers the opportunity to eliminate known disadvantages of CM therefore optimising workflow and reducing costs [7].

One of the major disadvantages of CM is the predominantly manual processing of specimens. In comparison to chemistry specimens, microbiology specimens are much more complex [6]. Thus, for years the common opinion was that microbiology was too complex to automate and that no machine could replace a human here [6]. It has been shown, however, that automated inoculation of samples can indeed be superior to manual inoculation with regard to pathogen recovery [8]. Furthermore, by manually processing of samples, incubation times and processing itselfare not guaranteed standardized and qualitatively equivalent. Automation enables a higher degree of standardization, which may be beneficial not only in terms of cost-effectiveness, but also in terms of gaining diagnostic quality. Recently, total laboratory automation (TLA) systems have been developed by several companies but only few laboratories have implemented them so far. Currently, there are three TLA solutions available, Kiestra TLA (BD Kiestra B.V., Drachten, Netherlands), full microbiology laboratory automation (FMLA; bio Mérieux, Inc., La Balme, France), and the WASPLab (Copan Diagnostics, Murrieta, CA) [6]. They all include track systems to move plates, use digital cameras to capture plate images and have automated incubators [6]. The first few results published about these TLA solutions in real practice suggest that productivity indices can be improved, diagnostic can be quickened and results are reproducible [9,10]. Due to TLA a total process time of about 26 hours from sample receipt to final result including susceptibility testing appears feasible. This would be a significant acceleration compared to CM and could impact clinical decisions and patients outcome. Another essential aspect of full automation is the standardized, automated image acquisition of cultures and thus coherently the possibility of digital image analysis and interpretation. This represents the means to standardize and reduce incubation times and accelerate processing of samples and susceptibility testing. Additionally, for the first time in clinical

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microbiology, TLA solutions introduce a quality assurance tool that allows even after a long time to assess bacterial growth retrospectively. Furthermore, TLA enables centralized virtual lab for outlying posts in remote areas, thus avoiding quality losses by long transport times.

However, they are also drawbacks to automation in clinical laboratory. Until now, scientific research assessing the benefits of automation in clinical microbiology is scarce. Is there really a benefit for the patient when diagnostic results are available earlier? Besides other questions about health economics this is the most important one that need to be answered by well-designed studies. In addition, the currently available TLA solutions are still very new and might yet be technological underdeveloped and immature. It could be years until the TLA solutions function at a capacity that allows them to be widely used. Not to mention that acquisition costs are yet enormous. Finally, while quality of the diagnostic results was mainly based on the experience and expertise of the microbiology staff in the past, in the course of automation it will much more depend on the method or apparatus used.

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