Development of an all-in-one transportable clinical bacteriology laboratory: feedback from testing a Mini-Lab prototype

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Introduction

Within MSF projects, many patients we treat have invasive bacterial infections, often in settings with increasing levels of antimicrobial resistance. However these projects frequently lack laboratory capacity to diagnose such pathogens, which complicates appropriate patient care. Since next-generation diagnostics adapted to low-resource settings (LRS) are unlikely to become available within the next five to ten years, MSF is currently working to rapidly develop a stand-alone, transportable laboratory, the "Mini-Lab", which uses existing diagnostics and antibiotic susceptibility testing (AST) of bloodstream infections, and adapts these to LRS. We describe the testing process for a prototype of the Mini-Lab, early results and lessons learned.

Methods

Development of the Mini-Lab involved a user-centered, iterative process with a mixed group of experts (ergonomists, designers, pedagogy specialists, and microbiologists) to develop technical requirements, calls for tenders, product selection, component development, and materials testing. In Jan 2019, we assembled all components (including tests, equipment, benches) into a full working prototype, installed at Laboratoire Hospitalo-Universitaire, Brussels. Individual test components are undergoing validation in European reference laboratories for diagnostic accuracy. We are assessing ergonomics, appropriateness and user-friendliness of the setup, diagnostic testing, and user guidance tools. Methods used include simulation of routine laboratory work, with non-microbiology students carrying out sample processing and test procedures, with simulated samples of known bacteria, and with evaluator observation and user questionnaires to collect feedback. 135 evaluator observations and 14 questionnaires were done.

Ethics

This innovation project did not involve human participants or their data; the MSF Ethics Framework for Innovation was used to help identify and mitigate potential harms.

Results

The assembled prototype consists of six foldable, sturdy transport boxes (~120kg each), transformable into standalone laboratory benches (80x120cm, adjustable working height, embedded power connections and light sources). It also includes all necessary laboratory materials, including 29 reagents and tests, with an average shelf-life of 18 months, and only eight requiring a cold chain. Pictograms posted on the modules guide users through the diagnostic workflow. An assessment of the prototype's user friendliness, carried out from 28 Jan 2019 to 14 Feb 2019) has already provided valuable information on optimizing Mini-Lab assembly and workflow management. This included feedback on the placement of materials, adaptation of light sources for users' visual comfort, addition of new consumables, and workflow refinement.

Conclusion

The development of the Mini-Lab has now reached the testing phase of a prototype including all components. Test users have responded positively with regard to ergonomics of the bench and modules, tests, and pictogram-based guidance, while module weight has emerged as a constraint. By identifying needed improvements early, these results will provide critical information for our iterative design process. All feasible, useful improvements will be made before the first Mini-Lab field evaluation, which is planned at an MSF-supported burn centre in Haiti, beginning in May 2019.

Conflicts of interest

None declared.

Jean-Baptiste Ronat

Jean-Baptiste is a microbiologist, specialising in bacteriology and antibiotic resistance. He joined MSF's Paris headquarters in 2012 to work on diagnostic and surveillance strategies for bacterial infections, after 10 years of involvement with MSF projects where he set up and supported a number of laboratories. Jean-Baptiste is co-creator, together with Dr Jan Jacobs of the Institute for Tropical Medicine Antwerp, Belgium, of a framework for clinical bacteriology in low-resource settings. He initiated the Mini-Lab project in 2016 and is now leading scientific development.