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Highlights

- AMR response is hindered by weak diagnostics in low-resource, conflict zones
- MSF advocates for strengthening manual culture and long-term capacity building
- Labs need supply chains, SOPs, and IPC/AMS integration to be sustainable
- Innovation is essential; tools like Antibiogo expand access to quality bacteriology
- Pragmatic investment in diagnostics and training is key to closing AMR response gaps

Advancing Clinical Bacteriology in Humanitarian Settings: The Collaborative Role of Médecins Sans Frontières

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Abstract

Antimicrobial resistance (AMR) is a growing global health threat, particularly in resource-limited and conflict-affected settings. Access to Diagnostics and Surveillance (D&S) is one of the key pillars to address AMR yet remains critically limited in many of these settings. Médecins Sans Frontières (MSF, Doctors Without Borders) has over a decade of experience in building and supporting bacteriology laboratories worldwide. A pragmatic model centred on manual culture-based bacteriology, innovation and capacity building is promoted, always integrated with Infection Prevention and Control (IPC) and Antimicrobial Stewardship (AMS) programs and collaboration with Ministries of Health. Moreover, innovative strategies such as the Mini-Lab or Antibiogo have been successfully integrated into numerous settings. Effective and sustainable AMR diagnostics are feasible in humanitarian settings with the right approach. However, without actionable steps, the gap in equitable access to AMR interventions will persist, leaving vulnerable populations at continued risk.

Keywords: antimicrobial resistance; humanitarian settings; clinical bacteriology; microbiology; laboratory capacity building; diagnostics

Introduction

AMR is an increasingly serious threat to global public health that was associated with 4.95 million deaths, including 1.27 million attributable deaths in 2019 (1). Projections indicate up to 169 million AMR-related deaths by 2050, including 39.1 million directly attributable deaths (2). At the second United Nations High-level meeting (UNHLM) on AMR in 2024, world leaders recognised that AMR is one of the most urgent global health threats and acknowledged the need for equitable and timely access to quality essential health-care services, including diagnostics. However, despite the urgency of the problem, access to quality bacteriology services remains a critical gap in healthcare, especially in resource-limited and conflict-affected regions, hindering effective responses to AMR.

Diagnostics and Surveillance (D&S) are fundamental in guiding antimicrobial treatment, supporting outbreak detection and response, and strengthening fragile health systems (3–5). In high-income countries, advanced diagnostic tools enable early detection and appropriate antimicrobial use. However, in resource-limited and conflict-affected settings, these technologies are often unaffordable or challenging to implement, leaving laboratories dependent on manual culture-based techniques, if any (6,7). Additional implementation challenges, such as unstable power supply, inaccessibility of quality consumables, harsh environmental conditions (e.g., high temperature, humidity, dust), and absence of skilled staff often arise. As a result, bacteriology outcomes turn unreliable for patient care and surveillance (8–11).

Doctors Without Borders (Médecins Sans Frontières, MSF) plays a key role in addressing these diagnostic gaps, particularly in humanitarian contexts where no other actors are present. At present, MSF advocates for a pragmatic approach: strengthening manual culture-based diagnostics and investing in long-term capacity building for laboratory staff in collaboration with Ministries of Health (MoH).

MSF has long been at the forefront of efforts to bridge these gaps by building or supporting bacteriology laboratories worldwide. This includes introducing manual culture-based techniques, staff training and innovative solutions such as the Antibiogo (12) and the Mini-Lab (13), which aim to improve the accessibility and reliability of diagnostics. MSF's approach prioritises sustainable laboratory support through structured supply chains, standardised methodologies, and integration with Infection Prevention and Control (IPC) and Antimicrobial Stewardship (AMS) programs. However, establishing and maintaining bacteriology laboratories in humanitarian settings remains challenging. Budget and logistics constraints, difficulties in procuring essential reagents, and a shortage of experienced microbiologists remain significant barriers. Additionally, donated high-tech equipment often proves ineffective when local expertise and reliable supply chains for reagents, consumables and maintenance are lacking. In contrast, MSF's model promotes that trained laboratory staff can sustain high-quality diagnostic practices even after external support diminishes.

By adhering to international standards and aligning with national regulations where possible, MSF integrates bacteriology services into broader AMR surveillance networks. This comprehensive approach, grounded in capacity building, tailored guidelines, and cross-sectoral collaboration, demonstrates that effective AMR diagnostics can be both feasible and sustainable in resource-limited settings.

While MSF's work in D&S spans multiple areas, including in vivo (imaging test) and in vitro diagnostics (biochemistry, haematology, and virology), this opinion paper specifically focuses on the critical role of bacteriology laboratories in addressing AMR-related challenges, excluding tuberculosis due to its distinct diagnostic and treatment protocols.

Filling diagnostic and surveillance gaps in fragile settings

Access to quality bacteriology laboratories remains a major gap in humanitarian settings. The African Society for Laboratory Medicine reported that only 1.3% of the 50,000 medical laboratories in the fourteen countries of the Antimicrobial Resistance and Antimicrobial Use Partnership (MAAP) conducted bacteriological testing in 2019-2020 (8). Moreover, in 2017, Barbé *et al.*, reported the existence of 485 accredited laboratories in Sub-Saharan Africa (79% of them in South Africa). No accredited laboratories were found in Central African Republic (CAR), Chad, Democratic Republic of Congo (DRC), Malawi, Sierra Leone, or South Sudan (7). The absence of these essential services severely limits the ability to diagnose infections, guide appropriate treatment, and monitor AMR trends.

To address these gaps, MSF started building and supporting bacteriology laboratories in 2014, starting with laboratories in Mali and Jordan to strengthen D&S in MSF-supported hospitals. Whenever possible, the support of existing public laboratories and collaborations with the MoH is prioritised. This includes capacity building of laboratory staff, introducing cultured-based techniques, implementing standard operating procedures and establishment reliable international and local supply chains at least during MSF involvement. Beyond MSF-supported or MSF-run laboratories, when possible, MSF also assesses external laboratories following an in-depth assessment by microbiology experts. These external laboratories could be any microbiology laboratory at the local, regional and national level. Their capacity is assessed by the MSF microbiology referent, who decides whether they meet the requirements for independent sample processing or if they require different levels of support to align with MSF standards. This process ensures that referred samples yield high-quality, reliable results, which are crucial to MSF's diagnostic and surveillance strategy.

Today, thanks to MSF, several of the underserved contexts have at least one high-quality, reliable bacteriology laboratory, or are planning to do so (Fig. 1). This is particularly significant in remote areas such as northern Nigeria or southern Mali. Furthermore, in Asia and the Middle East, MSF has significantly enhanced laboratory capacity, notably in MSF projects located in Afghanistan, Bangladesh, Iraq, and Yemen. Unfortunately, the two bacteriology laboratories supported in Gaza have recently been put on hold due to damage to the laboratory infrastructure, supply blockages at the borders and the exodus of staff, exacerbating the needs of the population (14,15).

As part of its commitment to strengthening diagnostic capacity, MSF has implemented different models to improve access to bacteriology services. Thirty-seven MSF projects have access to reliable bacteriology services. Of the bacteriology laboratories MSF runs, seven are Mini-Labs – this is a small-scale, simplified, standardised and quality-assured clinical bacteriology laboratory which is suited to MSF's contexts where laboratory technicians have little to no experience in bacteriology culture-based techniques. This concept, developed by MSF with its partners, enables the faster implementation of blood, urine and sterile body fluid sample analysis, enhancing the ability to guide AMS, detect outbreaks early and provide timely interventions. They are run in Afghanistan (Khost), CAR (Carnot), DRC (Rutshuru), Iraq (Mosul), Nigeria (Maiduguri), and South Sudan (Aweil, and Bentiu). MSF-supported, MSF-run and MSF-validated laboratories, including Mini-Labs, can serve several hospitals at once if suitable transport options are available, translating into timely and quality sample testing for thousands of patients every year, free at the point of care.

To ensure high-quality and sustainable results, MSF emphasizes the importance of limiting the number of specimen types processed (e.g., blood, CSF, urine) based on available resources and local priorities and focusing on quality rather than quantity.

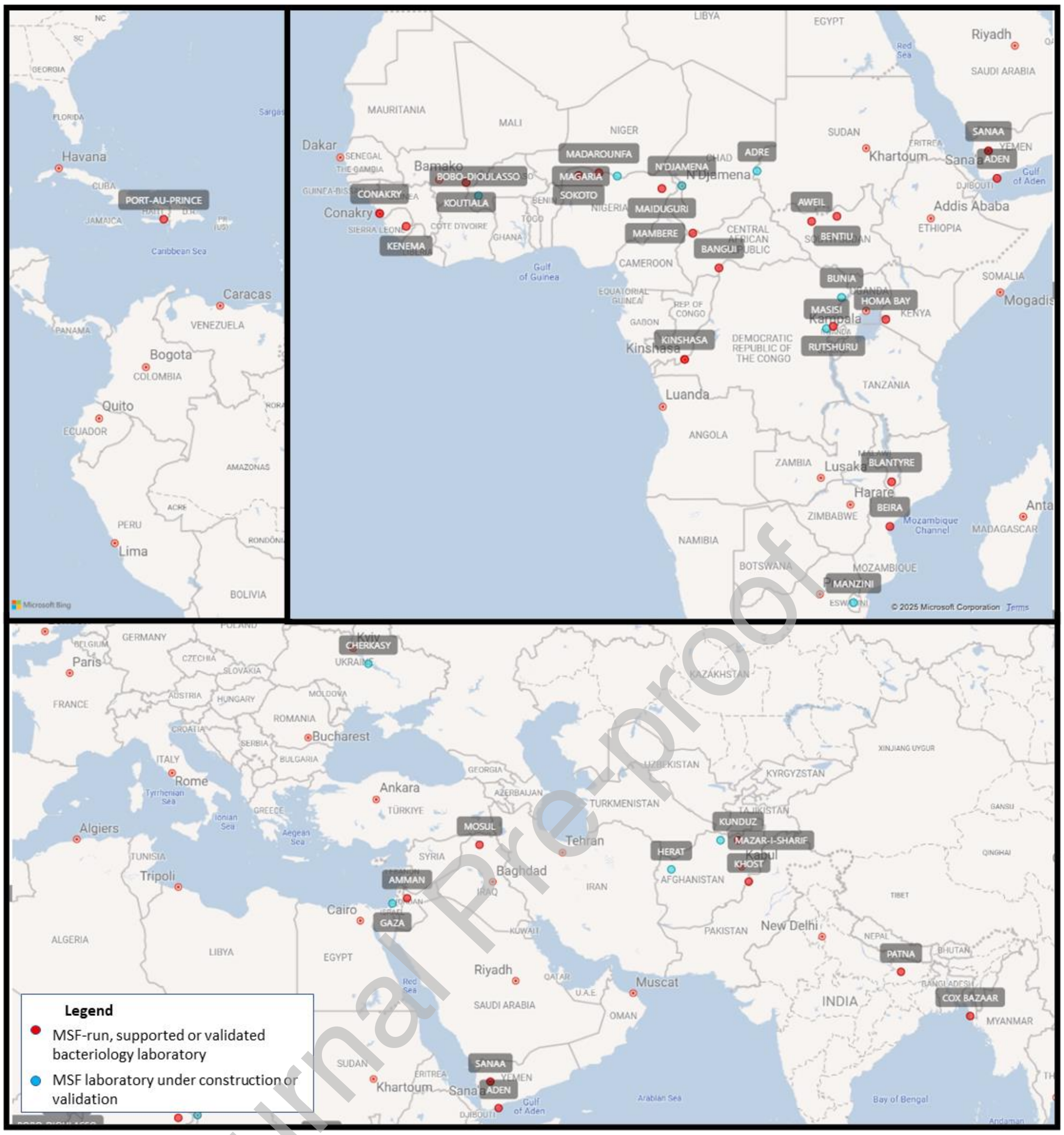

Figure 1. MSF run, supported and validated laboratories, current and planned.

Capacity building for sustainable impact

Healthcare solutions require investment in local capacity. By fostering local expertise, MSF not only improves immediate patient care but also strengthens health systems for the long term. Training of staff in bacteriology takes a long time, and the subsequent follow-up is even longer. However, it is crucial to ensure laboratory quality.

MSF strengthens capacity through structured training, hands-on supervision, and long-term support. Experienced microbiologists implement culture-based techniques using standardized MSF procedures for bacteriology. The local laboratory technicians undergo extensive training, typically lasting between 6 to 24 months, depending on the complexity of the techniques and required skills. After passing proficiency testing and validation, bacteriology activities are transferred from the experienced microbiologist to a locally hired laboratory supervisor. After handing over, MSF microbiologists conduct regular visits and audits to ensure adherence to the standards. Beyond individual training, MSF ensures sustainability by embedding local staff into teams, fostering continuous knowledge transfer, and progressively developing local leadership, with the most skilled staff advancing to supervisory roles. In parallel, improving the quality of specimen collection, including correct sampling sites, proper technique, clinical indications, and timely transport, is essential to ensuring the accuracy and clinical relevance of diagnostic results.

In addition to technical training, MSF provides a structured framework for laboratory operations, including tailored guidelines, quality assurance protocols, and data management using WHONET as a surveillance tool. These tools enhance diagnostic accuracy, support AMS, and contribute to global AMR surveillance efforts.

While IPC and AMS training lay the groundwork for safe and effective laboratory implementation, MSF's bacteriology training emphasises practical, hands-on experience—ranging from specimen collection and culture-based techniques to advanced interpretation of susceptibility testing. This approach ensures that laboratories not only function independently but also provide reliable, high-quality data to guide patient care and public health interventions.

Beyond laboratory training, capacity building, guidelines, and clinical support are also essential for IPC and AMS. Before a microbiology laboratory can be implemented in a particular project, IPC and AMS need to be in place, meaning trained focal points need to be put in place, an isolation room needs to be available, an action plan to respond to nosocomial outbreaks should be in place, etc. These components are integral to MSF's multidisciplinary approach to addressing AMR, ensuring coordinated efforts across the three AMR pillars: IPC, AMS and D&S.

Overcoming challenges and enhancing results interpretation through innovation

Despite access to laboratories, in many settings, the interpretation of antimicrobial susceptibility testing (AST) results continues to be challenging. This is especially true in resource-limited environments where laboratory staff may have limited training or no experience in bacterial isolation, identification, and AST interpretation using updated international guidelines. MSF addresses these by implementing clear and simplified standard operating procedures tailored to the needs of the setting and based on international bodies such as Clinical and Laboratory Standards Institute (CLSI) and European Committee on Antimicrobial Susceptibility Testing (EUCAST). These guidelines are essential for laboratory practice but can be complex and challenging to understand and implement, especially for laboratory staff with limited expertise in microbiology (17).

In addition, innovative approaches to result interpretation have been explored, resulting in the development of Antibiogo, a key tool to democratize AST interpretation (12). Antibiogo is an MSF's digital health tool that supports lab technicians in delivering accurate AST to raise the quality of data collected within hospitals, which in turn can be used to improve empirical treatments. By leveraging artificial intelligence, Antibiogo enables any microbiology laboratory technician to read and interpret an AST disk diffusion accurately directly on their phone. This tool not only empowers local health professionals but also ensures that patients receive appropriate treatments, reducing the misuse of antibiotics. Antibiogo is available in English and French and has been implemented in 9 countries both in MSF projects and at the national level in collaboration with the MoH of Afghanistan, CAR, DRC, Jordan, Mali, Mozambique, Nigeria, Sierra Leone, and Yemen. Future versions of the tool will also allow for interpretation of minimum inhibitory concentration (MIC) and the integration with WHONET and other laboratory information management systems (LIMS).

Robust surveillance systems are essential for tracking disease trends and guiding public health responses. MSF's integration of WHONET, a global software tool for AMR surveillance, into its laboratory activities represents a significant advancement. Strengthening the link between WHONET and advanced statistical tools and algorithms will facilitate more robust data analysis and improve evidence-based decision-making (18,19).

Conclusion

MSF's experience in implementing bacteriology laboratories using manual, conventional culture-based techniques rather than costly automated equipment or high-tech diagnostic tools demonstrates that even in challenging settings, it is possible to establish D&S services. This directly improves the quality of care and strengthens the global capacity to respond to emerging health threats.

As AMR continues to pose a global threat, MSF's experience underscores the urgent need for investment in diagnostics, capacity building, and surveillance in humanitarian contexts. Following the second United Nations High-level meeting (UNHLM) on AMR in 2024, global commitments must translate into practical, scalable solutions that are feasible for LMIC contexts. Without actionable steps, the gap in equitable access to AMR interventions will persist, leaving vulnerable populations at continued risk.

Priority actions should include the integration of microbiology in the core curriculum of higher education institutions globally, the continuous control of the quality of results, the establishment of information systems that enable linkage with clinical data, ensuring laboratory results reach the clinician promptly, moreover, these information systems could be semi-automated to prevent transcription errors and support results interpretation. The international community must keep on developing pragmatic and affordable innovations like power-independent devices, simplified technical guidelines, fit-for-purpose regulatory frameworks and provide technical support to validate adapted tools like Antibiogo.

Competing Interests

We declare no competing interests.

Data Sharing

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References

1. Murray CJL, Ikuta KS, Sharara F, Swetschinski L, Robles Aguilar G, Gray A, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. The Lancet. 2022 Feb;399(10325):629–55.

2. Naghavi M, Vollset SE, Ikuta KS, Swetschinski LR, Gray AP, Wool EE, et al. Global burden of bacterial antimicrobial resistance 1990–2021: a systematic analysis with forecasts to 2050. The Lancet. 2024 Sep;S0140673624018671.

3. Ombelet S, Ronat JB, Walsh T, Yansouni CP, Cox J, Vlieghe E, et al. Clinical bacteriology in low-resource settings: today's solutions. Lancet Infect Dis. 2018 Aug;18(8):e248–58.

4. World Health Organization (WHO). WHO fungal priority pathogens list to guide research, development and public health action. 2022.

5. World Health Organization (WHO). WHO Bacterial Priority Pathogens List. 2024. Report No.: ISBN 978-92-4-009346-1.

6. Markby J, Gygax M, Savoy C, Giebens Y, Janjanin S, Machoka F, et al. Assessment of laboratory capacity in conflict-affected low-resource settings using two World Health Organization laboratory assessment tools. Clin Chem Lab Med CCLM. 2023 May 25;61(6):1015–24.

7. Barbé B, Yansouni CP, Affolabi D, Jacobs J. Implementation of quality management for clinical bacteriology in low-resource settings. Clin Microbiol Infect. 2017 Jul;23(7):426–33.

8. Ondoa P, Kapoor G, Alimi Y, Shumba E, Osena G, Maina M, et al. Bacteriology testing and antimicrobial resistance detection capacity of national tiered laboratory networks in sub-Saharan Africa: an analysis from 14 countries. Lancet Microbe. 2025 Jan;6(1):100976.

9. Orekan J, Barbé B, Oeng S, Ronat JB, Letchford J, Jacobs J, et al. Culture media for clinical bacteriology in low- and middle-income countries: challenges, best practices for preparation and recommendations for improved access. Clin Microbiol Infect. 2021 Oct;27(10):1400–8.

10. Ombelet S, Barbé B, Affolabi D, Ronat JB, Lompo P, Lunguya O, et al. Best Practices of Blood Cultures in Low- and Middle-Income Countries. Front Med. 2019 Jun 18;6:131.

11. Wertheim HFL, Huong VTL, Kuijper EJ. Clinical microbiology laboratories in low-resource settings, it is not only about equipment and reagents, but also good governance for sustainability. Clin Microbiol Infect. 2021 Oct;27(10):1389–90.

12. Antibiogo. Antibiogo [Internet]. 2024. Available from: https://www.antibiogo.org/

13. MSF Foundation. Mini-Lab Diagnostic tool [Internet]. 2024. Available from: https://fondation.msf.fr/en/projects/mini-lab

14. Taher AQM, Aqel R, Alnajjar M, Walker C, Repetto E, Raad M, et al. Posttraumatic *Pseudomonas aeruginosa* Osteomyelitis in Mosul and Gaza: A Retrospective Cohort Study, 2018–2022. Open Forum Infect Dis. 2024 Sep 27;11(10):ofae579.

15. Moussally K, Abu-Sittah G, Gomez FG, Fayad AA, Farra A. Antimicrobial resistance in the ongoing Gaza war: a silent threat. The Lancet. 2023 Nov;S0140673623025084.

16. Açma A, Williams A, Repetto E, Cabral S, Sunyoto T, Woolley SC, et al. Prevalence of MDR bacteria in an acute trauma hospital in Port-au-Prince, Haiti: a retrospective analysis from 2012 to 2018. JAC-Antimicrob Resist. 2021 Jul 12;3(3):dlab140.

17. Iskandar K, Molinier L, Hallit S, Sartelli M, Hardcastle TC, Haque M, et al. Surveillance of antimicrobial resistance in low- and middle-income countries: a scattered picture. Antimicrob Resist Infect Control. 2021 Mar 31;10(1):63.

18. Dikkatwar M, Vaghasiya J. Development and application of WHONET software in hospital antibiogram. Clin Epidemiol Glob Health. 2023 Nov;24:101424.

19. Hosaka Y, Hirabayashi A, Clark A, Baker M, Sugai M, Stelling J, et al. Enhanced automated detection of outbreaks of a rare antimicrobial-resistant bacterial species. Denkel LA, editor. PLOS ONE. 2024 Oct 24;19(10):e0312477.