Mobile TB Lab: Diagnostic algorithm for peripheral lymph node tuberculosis using portable station

Project type

☐ interdisciplinary pilot project ☒ cross-sector project ☐ global health postdoc fellowship

Research areas involved (check all that apply)

☒ Biomedical sciences ☒ Public health
☐ Social sciences and humanities ☐ Engineering and other sciences

Project duration

November 2022 – October 2024

Project team

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Case Study

Introduction Tuberculosis is one of the most serious infectious diseases around the world, with the highest prevalence in Asia and Sub-Saharan Africa. Early and accurate diagnosis of tuberculosis is central to ensuring the proper treatment and curbing the transmission of the disease. Despite significant burden, the diagnosis of peripheral lymph node tuberculosis, the most prevalent form of extra pulmonary tuberculosis (EPTB), has been challenging in low resource settings. To meet the existing needs, Mobile-TB-Lab study set out to evaluate two innovative approaches including thermal imaging and recombinase aided amplification assay (RAA) in Minoo for point-of-need diagnosis of lymph node tuberculosis. The synergy of these index tests is expected to pave the way for rapid detection of EPTB in resource constrained settings including Bangladesh and Uganda. Moreover, the operational feasibility of the aforementioned innovative approaches would facilitate their implementation within the national health programs in the disease inflicted countries.

Project Summary Tuberculosis cases were recruited in the BSMMU OPD (Bangladesh) and outpatient Clinics and inpatient wards at Mulago National Referral Hospital and Kiruddu National Referral Hospital (Uganda). Each case underwent thermal imaging, Fine Needle Aspiration, chest X-ray, and neck Ultrasound. Aspirated samples were further tested using various methods like microscopy, culture, cytopathology, GeneXpert, and DNA extraction. Ultimately, qPCR and RPA assays were performed on the extracted DNA. A neural network was trained on this data using Python, Tensorflow, and Keras. The model was optimized through cross-validation and evaluated on a separate test dataset labeled by either “TB” or “No TB.”

Findings A total of 104 suspected patients with cervical lymphadenitis were enrolled from BSMMU in Bangladesh. Among the suspects, 52 patients were diagnosed as cases of LNTB according to the study protocol. Analysis revealed a higher prevalence of tuberculous infection among the low-income individuals (<7000 BDT), and most of the patients were comparatively young (<31 years). Clinical parameters such as fever, discharging sinus, enlarged cervical lymph nodes (>1 cm in length or width), and purulent lymph node aspirate were associated with increased likelihood of TB infection. Being a multicenter study, another 100 suspected TB patients were enrolled in Uganda. Among the enrolled patients, twenty-seven presented with cervical lymphadenopathy suggestive of peripheral LNTB while 73 were confirmed and suspected TB without lymphadenopathy. The GeneXpert Ultra detected 7/26 samples as positive, of which 3 were negative by AFB smear microscopy and both culture methods. One of the GeneXpert positive samples yielded a positive growth on MGIT. The performance and cost-effectiveness of RPA assays with rapid DNA extraction and of the AI model are currently under evaluation.

Conclusion The results of this study show that extra-pulmonary TB diagnosis using conventional methods in resource-limited settings is a significant burden on the health system. Furthermore, the clarity of test results is not always guaranteed, even when different methods are used. Acceptance of new diagnostic methods, such as thermal imaging, was shown to be easy to implement. Evaluations of thermal imaging and RPA are still ongoing and need to be interpreted in the overall context.

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Funding

GLOHRA is funded by the German Federal Ministry of Education and Research (BMBF) as a part of the German Alliance for Global Health Research (GLOHRA). [Grant number: 01KA2217].

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Last updated: 18/02/2025
File name: 250202_GLOHRA_case study_Mobile TB Lab.docx