

## Strengthening tuberculosis diagnosis in a low-resource setting: experience learned in Dodoma, Tanzania

Angela Cannas<sup>1</sup>, Maria G Paglia<sup>1</sup>, Dominick C Sakhoo<sup>2</sup>, Francesco Vairo<sup>1,4</sup>, Basra Doulla<sup>3</sup>, Boniface Nguhuni<sup>2</sup>, Zainab Chaula<sup>2</sup>, Raphael Mlumba<sup>2</sup>, Maurizio Mirrione<sup>1</sup>, Nazario Bevilacqua<sup>1</sup>, Emanuele Nicastrì<sup>1</sup>, Pasquale De Nardo<sup>1</sup>, Silvia Meschi<sup>1</sup>, Enrico Girardi<sup>1</sup>, Vincenzo Racalbuto<sup>4</sup>, Giuseppe Ippolito<sup>1</sup>

<sup>1</sup>National Institute for Infectious Diseases (INMI) "L. Spallanzani", Rome, Italy

<sup>2</sup>Dodoma Regional Hospital (DRH), Dodoma, United Republic of Tanzania

<sup>3</sup>Central Tuberculosis Reference Laboratory (CTRL), Dar-es Salaam, United Republic of Tanzania

<sup>4</sup>Italian Development Cooperation (DGCS), Italian Ministry of Foreign Affairs, Rome, Italy

### Abstract

**Introduction:** Diagnosing tuberculosis in low-resource settings mostly relies on sputum smear microscopy. Improvement through capacity building is a priority. This project aimed to strengthen tuberculosis diagnosis at an intermediate level laboratory.

**Methodology:** The Italian National Institute for Infectious Diseases and the Italian Development Cooperation closely collaborated with regional and national institutions and reference laboratories to provide laboratory setup, equipment and reagents, personnel training, and the implementation of culture and quality assessment programs at Dodoma Regional Hospital, Dodoma, Tanzania.

**Results:** Microscopy sensitivity was increased, personnel were trained, and culture techniques and quality assessment programs were introduced.

**Conclusions:** Implementing tuberculosis diagnosis in resource-constrained settings is feasible and represents a basis for further strengthening.

**Key words:** laboratory capacity building; AFB smear microscopy; TB culture

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### Introduction

Tuberculosis (TB) remains a major cause of human morbidity and mortality, with an estimated 9.4 million new cases and 1.8 million deaths per year, with most cases occurring in low-income countries [1].

In resource-limited settings, tuberculosis diagnosis relies on sputum smear microscopy [2-3], with low and variable sensitivities (20-80%) [4], especially in paucibacillary pediatric and HIV-associated TB patients [5]. TB laboratories present several weaknesses: overworked and insufficiently trained personnel, inconsistent reagent supply, and poorly maintained equipment [2]; thus there is a critical need for investments in laboratory infrastructure, capacity building, and quality assurance [2,6-9].

In Tanzania, all level laboratories perform smear microscopy to diagnose TB, culture is performed in six intermediate laboratories (either public or private), and drug-susceptibility testing is available at the Central Tuberculosis/Leprosy Reference Laboratory in Dar-es-Salaam.

The National Institute for Infectious Diseases, Italy, and the Italian Development Cooperation (DGCS, Ministry of Foreign Affairs), in collaboration with the Tanzanian Ministry of Health and Social Welfare (MOHSW) and the National Tuberculosis/Leprosy Program, conducted a project at the Dodoma Regional Hospital (DRH), a public regional reference hospital in Tanzania. The aim of the project was to improve the quality of TB diagnosis through laboratory organization, personnel training, and the implementation of concentrated sputum smear, culture techniques, and quality assessment programs. Here we describe the methodology applied and preliminary results obtained.

### Methodology

The project was initiated in 2009 and is currently on-going.

The first step was to restructure the tuberculosis section in the hospital laboratory. Laboratory spaces

and workflow were organized to create a TB area separated from the main laboratory. All instruments, benches, consumables, reagents and preventive personnel equipment needed for implementing TB microscopy and culture were purchased. The second step, aimed at improving the quality of TB diagnosis at DRH, focused on personnel training, the introduction of concentrated sputum microscopy, TB culture, and external quality assessment programs.

These activities were conducted as part of a Health Cooperation Programme described in the Memorandum of Understanding between the United Republic of Tanzania and the Republic of Italy.

## Results

### *Personnel training*

Three laboratory technicians were selected and trained in TB diagnosis and bio-safety procedures related to aerosol production in the restructured laboratory (Figure 1). Throughout the project, National Institute for Infectious Diseases specialists provided on-the-job training at DRH. Additional courses at the Central Tuberculosis/Leprosy Reference Laboratory were supported by the project. The technicians then guided, trained and supervised other DRH personnel. Standard operative protocols were prepared according to World Health Organization (WHO) and national guidelines. The entire laboratory staff received general bio-safety training.

### *Implementation of sputum smear microscopy*

In November 2009, smear microscopy was implemented through on-the-job personnel supervision and introduction of optimized smear

microscopy by sputum concentration. Smears were stained with Ziehl-Neelsen and analyzed by conventional light microscopy by two independent technicians. The WHO/IUATLD reporting system was applied.

A preliminary evaluation of the impact of our intervention compared the number of TB patients reported in 2009 (prior to intervention) with that of 2010, during implementation and supervision. In 2009, 175 (11.2%) of the 1,566 patients arriving at DRH for TB diagnosis were smear positive, while in 2010, 280 (14.2%) out of 1,976 patients received a TB diagnosis (Table).

### *Introduction of TB cultures*

Lowenstein-Jensen culture was introduced in April 2010, supporting a national plan aimed at enabling intermediate regional laboratories to perform solid culture and act as referral centres. To assess whether the laboratory was feasible for performing cultures, 301 Lowenstein Jensen inoculations were prepared from smear-positive sputa. *M. tuberculosis* isolates were confirmed by commercial speciation test and shipped to the Central Tuberculosis/Leprosy Reference Laboratory for drug-susceptibility testing. Positivity was confirmed for all cultures by the national reference laboratory: none resulted contaminated.

Drug-sensitivity testing resulted in 287/301 (95%) samples sensitive to first-line drugs, 13/301 (4.3%) resistant to single drugs (6 to SM, 3 to EMB, 3 to INH, 1 to RIF), and 1/301 (0.3%) to two drugs (INH and SM).

### *Introduction of Quality Assessment Programs for smear microscopy*

Internal quality assessment already existed in the laboratory in 2009. In 2010, the National Tuberculosis/Leprosy Program introduced an external quality assessment (EQA) program for AFB smear microscopy in Dodoma region. DRH was chosen to coordinate the regional EQA, and National Institute for Infectious Diseases specialists, in agreement with the National Tuberculosis/Leprosy Program, contributed to implementing EQA by visiting and supervising 10 peripheral laboratories.

## Discussion

Laboratory capacity building is essential for tuberculosis control. In Tanzania, as in other economically restrained countries, TB diagnostic laboratories present deficits in infrastructure, shortage

**Figure.** Tuberculosis Diagnosis Laboratory at Dodoma Regional Hospital



**Table.** Comparison of TB case detection rates in 2009 and 2010 at the DRH laboratory

	2009	2010
<b>AFB negative (% of total tested)</b>	1,391 (88.8%)	1,696 (85.8%)
<b>AFB positive (% of total tested)</b>	175 (11.2%)	280 (14.2%)
<b>Total patients tested</b>	1,566	1,976

Abbreviations: AFB: acid fast bacilli

of trained personnel and reagents, lack of quality programs, and disregard of safety issues [2]. We describe our experience in strengthening TB diagnosis at a public regional referral laboratory. A similar experience in Pemba Island, supporting the Zanzibar National TB Control Program aimed to decentralize TB diagnostics, was conducted with satisfactory results [10]. We are currently promoting tuberculosis capacity building, aimed at giving DRH the role of referral institute as part of the national expansion plan for decentralizing TB diagnostic services.

Implementing a cooperation program to support the TB laboratory in DRH resulted in an increased number of samples. The introduction of sputum-concentration for AFB microscopy, already evaluated by others [3,4], rapidly became laboratory routine, and the test sensitivity and case detection rates increased. This improvement is likely due to the introduction of a more sensitive methodology and the supervision of personnel. This explanation is supported by the 2009-2010 comparison of data in TB case detection, prior to and after our intervention.

Solid-medium cultures were easily incorporated into laboratory routine, demonstrating that the Dodoma laboratory has the potential to become a reference centre for TB culture in the region. The laboratory is currently improving adherence to national and WHO guidelines, strictly collaborating with other reference laboratories. Introduction and implementation of an external quality assessment system was part of this team effort, aimed at improving the quality of TB diagnosis, ultimately to increase case detection and disease control.

In conclusion, our experience indicates that implementing TB diagnostics in a resource-constrained setting is feasible. The high-quality level of cooperation with the regional and national institutions involved is the most important component of capacity building, and it represents a major achievement in terms of tuberculosis control and public health improvement.

Although the results obtained through this collaborative path are preliminary, they may represent

the basis for solid and sustainable improvement of TB diagnosis.

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**Corresponding author**

Angela Cannas  
National Institute for Infectious Diseases (INMI) “*L. Spallanzani*”  
Via Portuense 292  
00149 Rome, Italy  
Email: [angela.cannas@inmi.it](mailto:angela.cannas@inmi.it)

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