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CASE STUDY

"Think. Test. Treat TB" in Action: An Innovative Primary Care and Public Health Partnership to Improve Tuberculosis Prevention and Care

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Tuberculosis (TB) elimination in the United States hinges on large-scale TB screening, testing, and preventive treatment of individuals at risk for TB disease. However, the path from TB screening to TB preventive therapy (TPT) completion is not straightforward and relies on collaboration between public health departments and primary care providers to deliver quality TB services. North East Medical Services (NEMS) is a federally qualified community health center in the San Francisco Bay Area that provides primary care services to a large low-income Asian immigrant population at increased risk for TB infection and disease. To address a gap in primary care guidance on how to manage a patient who is asymptomatic and TB screening test–positive with abnormal chest imaging, NEMS and the San Francisco Department of Public Health TB Clinic, with support from the California Department of Public Health and University of California, San Francisco as partners, collaborated to utilize both provider education and radiology, laboratory, and electronic health record (EHR) systems modifications as decision aids for TB risk stratification of patients for home collection TB sputum evaluation and/or TB clinic referral before TPT is offered. A multidisciplinary group made up of local provider stakeholders from TB public health, infectious disease, pulmonary care, and primary care was convened in August 2022 to develop novel primary care workflows surrounding asymptomatic patients' abnormal chest imaging following a positive TB screening test. This new strategy, rolled out from August to December 2022, included trainings for radiologists and laboratory staff in addition to primary care providers, EHR modifications

to support TB evaluation, and standardized TB radiology language to enhance clinical communication. The TB risk stratification algorithm and associated EHR modifications and trainings supported provider decision-making and led to a significant improvement in the quality of TB diagnostic evaluation; notably, the number and proportion of complete sputum evaluation from preimplementation to postimplementation of the strategy increased (21% [20 of 95] in 2022 vs. 63% [85 of 135] in 2023, $P < 0.05$). Through this multipronged approach, this community health center simplified TB prevention workflows for primary care providers and streamlined the provider decision-making process to refer patients at higher risk for developing TB disease to the TB clinic.

KEY TAKEAWAYS

- Tuberculosis (TB) evaluation following abnormal chest imaging for asymptomatic patients with positive TB screening tests is complex and often not conducted in primary care due to lack of provider education and clear guidance.
- A multipronged approach involving multiple stakeholders in the design, training, tools, and implementation for the new care model is essential for simplifying TB evaluation workflows and provider decision-making, leading to enhanced appropriate referrals to the TB clinic.
- Specific risk-stratification language can support provider decision-making and lead to improved compliance with diagnostic testing guidelines.
- The future development of a radiology scoring system — similar to ones used for breast, lung, and liver cancer screening — would be an invaluable tool to support diagnosis and treatment of active and latent TB on a larger scale.
- Continued engagement and collaboration between public health and primary care are essential for the delivery of quality TB preventative services.

The Challenge

Robust partnership between public health and primary care is critical for establishing a path toward tuberculosis (TB) elimination. Although TB is a leading infectious killer globally, the United States is a low-incidence setting (2.5 cases per 100,000 persons in 2022),[1] in which more than 80% of active TB disease cases arise from persons with latent tuberculosis infection (LTBI).[2] TB elimination in the United States hinges on large-scale TB screening, testing, and preventive treatment of individuals at risk for TB disease. However, the path from TB screening to preventive treatment completion is not straightforward, requiring public health and primary care provider (PCP) collaboration to deliver quality TB services. In 2022, the Centers for Disease Control and Prevention (CDC) launched its Think. Test. Treat TB campaign in multiple languages

to raise TB awareness and encourage TB screening and treatment among at-risk individuals, communities, and their health care providers; additionally, the California Department of Public Health published *Preventing Tuberculosis in Your Clinical Setting: A Practical Guidebook*, intended as a tool for clinical leadership to scale up TB prevention in clinics and health systems.[3]

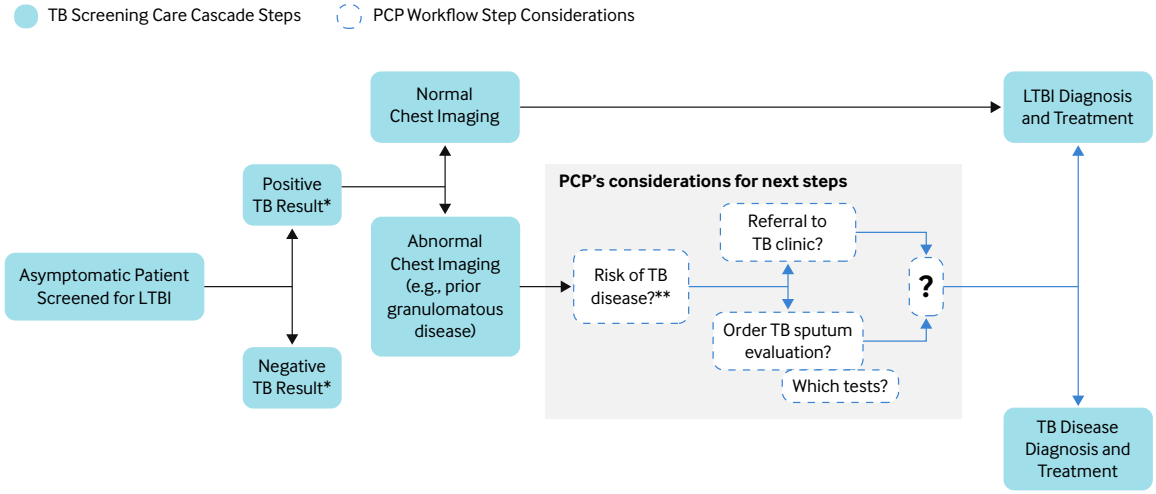
The U.S. Preventive Services Task Force recommends TB screening for persons at increased risk for TB to prevent active TB disease.[4] The process for TB screening, diagnosis, and decision to recommend preventive treatment relies on ensuring that active TB disease is not missed, introducing substantial complexity (Figure 1).

A positive TB screening test prompts a chest X-ray to evaluate for active TB disease before offering tuberculosis preventive therapy (TPT). When the chest X-ray is abnormal, PCPs must decide whether further TB evaluation is needed, including sputum testing with acid-fast bacilli (AFB) smear and culture as well as the mycobacterium tuberculosis (MTB) nucleic acid amplification test (NAAT).

FIGURE 1

Asymptomatic Tuberculosis (TB) Screening Workflow and Primary Care Provider (PCP) Challenges with Decision-Making Following Abnormal Chest Imaging

When chest imaging for an asymptomatic patient with a positive TB screening test is abnormal, PCPs must consider the patient's risk for TB disease and whether they can prescribe TB preventive treatment, should perform additional TB evaluation tests, or should refer to the TB clinic. This decision is complex, and standards of care and clinical workflows around this area are lacking. Our initiative was designed to address these challenges.



*In California, using a 10-mm cutoff is the standard due to the higher incidence of TB in the state compared with other parts of the United States.
**This indicates the person's risk of developing TB disease after assessing LTBI status.

LTBI = latent tuberculosis infection, PCP = primary care provider, TB = tuberculosis.
Source: The authors

Implementing sputum testing requires specialized provider knowledge, health system capacity, multiple patient visits to a laboratory, and 6 to 8 weeks for final results. Unfortunately, there is a lack of clear, standardized pathways between public health systems and primary care delivery models for conducting and communicating diagnostic testing, including sputum evaluation, interpreting chest radiography, and initiating TPT, for individuals with LTBI who are at risk for developing active TB disease.

> *"Unfortunately, there is a lack of clear, standardized pathways between public health systems and primary care delivery models for conducting and communicating diagnostic testing … for individuals with latent tuberculosis infection who are at risk for developing active tuberculosis disease."*

San Francisco has one of the highest TB incidence rates in the United States; in 2023, there were 69 new cases with active TB (8.1 cases per 100,000 persons), which is greater than both national and California rates of 2.9 cases and 5.4 cases per 100,000 persons, respectively.[5] Furthermore, San Francisco's Asian and Pacific Islander residents, who make up approximately 35% of the city's and county's population,[6] had an incidence rate of 15.9 per 100,000 persons, which is nearly 10 times greater than the 1.6 per 100,000 among non-Hispanic white residents.[5] This disparity is driven by the epidemiology of TB in the United States, in which those born in high TB–burden settings are often infected in their home country and may only manifest active disease much later in life.[7-10]

North East Medical Services (NEMS) is a federally qualified community health center in the San Francisco Bay Area that provides primary care services to a large low-income Asian immigrant population at increased risk for TB infection and disease. In 2022, of the 68,665 patients served across NEMS's 19 clinic locations, 88% were Asian, 80% were limited English proficient, and 78% had Medicaid (including those with Medicare–Medicaid dual eligibility). That year, 25% (14 of 57) of all reported TB cases in San Francisco occurred among patients who received medical services at NEMS.[11] For more than a decade, NEMS Provider Champions have collaborated closely with the San Francisco Department of Public Health (SFDPH) TB Clinic (without external funding sources) to provide trainings that support the NEMS PCPs in incorporating best practices in TB care delivery, such as the design of TB screening risk assessments, the preferential use of interferon-gamma release assays over tuberculin skin testing for TB testing in non-U.S.–born patients, and TPT with short-course rifamycin regimens over longer isoniazid regimens.[12] Key to establishing a strong partnership between NEMS and SFDPH was the identification of a PCP champion, such as a medical director or director of quality improvement, with both clinical and administrative oversight to implement systems-level changes (e.g., electronic health record [EHR] modifications, development of interdisciplinary workflows, and inclusion of internal TB quality metrics in the form of provider report cards) that would improve the quality of TB care.

In the May 2022 annual provider education session, the SFDPH TB Controller included a case example of a patient with a positive TB screening test and abnormal chest imaging findings consistent with prior granulomatous disease, encouraging NEMS's PCPs to order a sputum evaluation and refer to the SFDPH TB Clinic in such circumstances. Although this recommendation was meant to educate PCPs on the increased risk of TB disease among individuals with radiographic findings that could be associated with TB, this case example was generalized to apply to a broad range of abnormal radiographic findings, which resulted in a large increase in referrals to the public health TB clinic, including for numerous patients with very low–TB risk chest imaging findings, thereby potentially delaying their TPT and exceeding the public health department's capacity to see and evaluate all patients. The challenge we now faced was to develop a health system approach that achieved the public health goal of not missing any case of TB disease during expansion of LTBI testing at a population level while using a primary care delivery approach of providing efficient and individualized care in a community setting.

> *"Key to establishing a strong partnership between North East Medical Services and the San Francisco Department of Public Health was the identification of a primary care provider champion, such as a medical director or director of quality improvement, with both clinical and administrative oversight to implement systems-level changes."*

The Goal

NEMS and the SFDPH TB Clinic aimed to equip PCPs with the tools to better navigate the complexities of TB evaluation, such as when a patient undergoing asymptomatic TB screening is found to have abnormal chest imaging and the PCP must decide whether to refer to the TB clinic, order TB sputum evaluation, or offer TPT. The goal was to not only utilize provider education, but also to implement radiology, laboratory, and EHR systems modifications that could serve as built-in risk stratification tools for PCPs as they usher patients through the LTBI care cascade.

The Execution

A volunteer work group made up of local provider stakeholders from infectious disease, pulmonary care, primary care, and TB public health was convened in August 2022 to develop recommended primary care workflows for asymptomatic patients' abnormal chest imaging following a positive TB screening test.

The work group sought existing U.S. and California guidance for TB risk stratification models to determine the need for sputum evaluation based on specific chest imaging findings in the setting of asymptomatic screening; this guidance included the U.S. Department of State DS-3030 TB worksheet for medical examination of immigrant and refugee applicants,[13] the U.S. Department

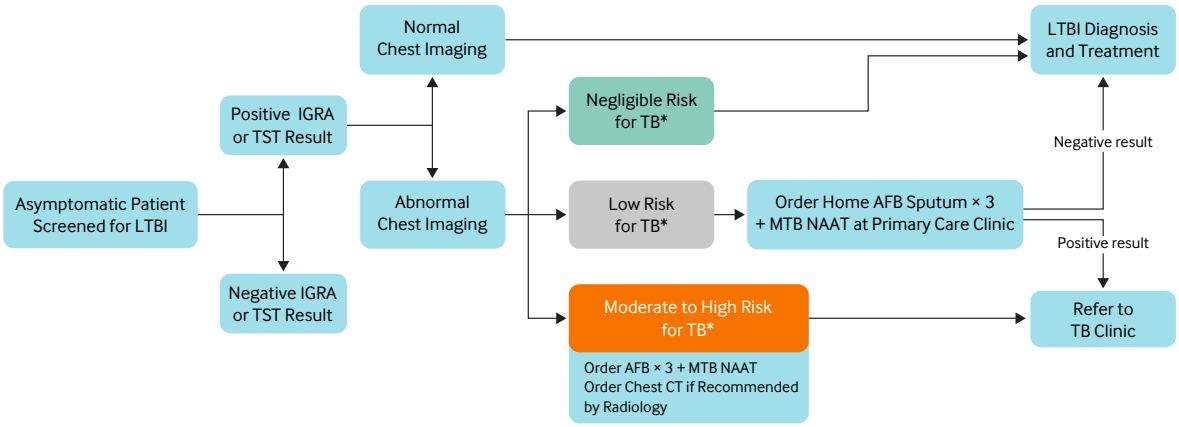
of Health and Human Services and CDC's 2008 technical TB guide for civil surgeons,[14] and the California adult TB risk assessment.[15]

The work group developed a risk stratification algorithm for PCPs managing the asymptomatic patient with a positive TB screening test and abnormal chest imaging (Figure 2 and Table 1). The algorithm distinguished between radiographic findings consistent with negligible, low, and moderate to high risk. Patients with negligible risk would be diagnosed with latent TB and offered TB preventive treatment. Patients with low risk were advised to have three AFB smear and culture sputum tests and one MTB NAAT in the primary care setting. Patients with moderate to high risk would be referred to the TB clinic; however, the initiation of TB sputum evaluation and/or the addition of chest computed tomography (CT) imaging if recommended by radiology could occur in parallel with coordination by the PCP.

FIGURE 2

Abnormal Chest Imaging Risk Stratification Workflow for the Asymptomatic Patient Who Is Interferon-Gamma Release Assay or Tuberculin Skin Test–Positive

In this clinical algorithm developed for primary care providers, an asymptomatic patient with a positive tuberculosis (TB) screening test and abnormal chest imaging is risk stratified into negligible risk (green), low risk (gray), or moderate to high risk (orange) for TB based on the radiographic findings listed in Table 1. Patients with negligible risk should be given a latent tuberculosis infection (LTBI) diagnosis and offered TB preventive treatment without further evaluation. Patients with low risk should complete three acid-fast bacilli (AFB) smear and culture sputum tests and one mycobacterium tuberculosis nucleic acid amplification test (MTB NAAT) through their primary care clinic. Patients with moderate to high risk should be referred to the TB clinic and complete TB sputum evaluation and chest computed tomography (CT) in parallel if recommended by radiology.



*Chest imaging abnormalities for each TB risk category are listed in Table 1.
AFB = acid fast bacilli, CT = computed tomography, IGRA = interferon-gamma release assay, LTBI = latent TB infection, MTB NAAT = mycobacterium TB nucleic acid amplification test, TB = tuberculosis, TST = tuberculin skin test.

Source: The authors

Table 1. Abnormal Chest Imaging Risk Stratification and North East Medical Services Radiology Standardized Language for Tuberculosis Chest Imaging

TB Risk Category	Negligible Risk	Low Risk	Moderate to High Risk
Chest imaging findings	• Normal lungs with or without bony or cardiac abnormalities • Solitary calcified nodule/granuloma • Isolated pleural thickening	• Discrete fibrotic scar with or without volume loss/retraction or linear opacity • Discrete nodule/granuloma without calcification	• Cavitary lesion • Infiltrate/consolidation • Nodule with poorly defined margins • Pleural effusion • Hilar or mediastinal lymphadenopathy • Miliary nodular pattern
Standardized language for chest imaging	No radiographic evidence of active TB disease	Likely old granulomatous disease; correlate clinically and consider sputum evaluation to rule out TB disease	Not applicable*

TB = tuberculosis. *No standardized language was deemed necessary because radiologists were comfortable conveying higher-risk findings on imaging and including broader differentials for workup specific to each individual study. Source: The authors, informed by citations noted.[13-15]

This algorithm was presented at the August 2022 monthly adult medicine provider meeting during a 15-minute presentation reviewing TB testing, evaluation, and TPT workflows with 46 (77%) providers present (Figure 2). NEMS PCPs were reminded of what constituted complete American Thoracic Society (ATS), CDC, and Infectious Diseases Society of America (IDSA) sputum evaluation. Following the presentation of the algorithm to providers, the SFDPH TB Controller also provided instructions for the NEMS's laboratory department on how to counsel patients on proper techniques for home morning sputum collection and provided in-language patient materials located on the SFDPH website that were develop by TB clinic nursing staff.

> *"The challenge we now faced was to develop a health system approach that achieved the public health goal of not missing any case of tuberculosis disease during expansion of latent tuberculosis infection testing at a population level while using a primary care delivery approach of providing efficient and individualized care in a community setting."*

In October 2022, the TB Controller suggested the colocation of MTB NAAT and AFB sputum tests on the NEMS laboratory ordering menu due to an observation that PCPs were ordering TB sputum evaluation without MTB NAAT. At the time, the MTB NAAT order was only accessible through a specialty microbiology ordering template that was not easily accessible for PCPs. In November 2022, an EHR modification was made to add the MTB NAAT adjacent to the AFB sputum smear and culture on the main laboratory ordering menu to encourage PCPs to order the complete ATS/CDC/IDSA-recommended TB sputum evaluation.

In December 2022, NEMS and SFDPH worked with the University of California, San Francisco (UCSF) Curry International Tuberculosis Center, a CDC-funded TB Center of Excellence site, to help organize a 1-hour TB radiology training session for NEMS's three general radiologists by a UCSF TB radiologist at the county hospital. The session included NEMS case studies and nuanced examples of negligible-risk, low-risk, and moderate- to high-risk chest imaging.

With facilitation by the NEMS TB Provider Champion, the NEMS radiologists developed standardized language to be included in their TB chest X-ray reports that would convey to ordering PCPs whether further TB evaluation should be considered (Table 1).

Hurdles

The May 2022 TB provider training at NEMS had emphasized TB clinic referral for evaluation of patients with evidence of prior granulomatous disease on chest imaging without discerning which findings suggested low versus higher TB risk. Parallel LTBI testing scale-up efforts at NEMS at this time resulted in an increased number of asymptomatic patients with positive TB screening tests and abnormal chest imaging, which led to a large increase in patient referrals to the local TB clinic with negligible or very low risk of TB disease.

> *"The algorithm distinguished between radiographic findings consistent with negligible, low, and moderate to high risk."*

The education provided to a PCP by a radiograph interpretation or consultant feedback is, by nature, on a case-by-case basis, making it challenging to identify and actualize opportunities for interdisciplinary and interagency communication and care improvement. Despite general instructions to use a risk-stratified approach developed by the TB Controller and the NEMS TB Provider Champion (Figure 2), many PCPs did not feel confident in recognizing chest imaging findings that reflected negligible versus low versus moderate to high TB risk. Provider education alone on which chest imaging findings warranted sputum was too complex to remember and was insufficient to change behavior.

Unlike for other common imaging tests performed in primary care for screening (e.g., mammography and low-dose CT lung cancer screening), there exists no standardized radiology scoring system to risk stratify abnormal chest imaging findings by their risk for active TB disease. Although standardized language was developed by NEMS radiologists for internal use, TB chest imaging reports from outside imaging centers remained widely variable in their approach of conveying TB risk.

The Team

Several key stakeholders were involved in making the TB evaluation workflows described possible.

From NEMS, internal quality improvement efforts were coordinated by the TB provider champion, who serves as both a PCP and clinical lead with administrative time and oversight. NEMS's Radiology Manager coordinated training of NEMS's radiologists who incorporated the TB risk stratification language into TB evaluation chest X-ray reports. The Laboratory Manager coordinated staff trainings on how to instruct patients on TB sputum collection, and NEMS's Informatics staff created EHR modifications for TB sputum and extracted EHR data for tracking key metrics.

From SFDPH, the TB Controller/Infection Diseases Specialist provided annual TB provider education and served as the main contact for feedback to NEMS providers and laboratory staff on TB clinic referrals as well as navigation of TB clinic recommendations and patient education resources for home sputum collection.

> *"There was a statistically significant increase in the proportion of patients who completed all three acid-fast bacilli smears and culture as well as mycobacterium tuberculosis nucleic acid amplification tests as per American Thoracic Society/Centers for Disease Control and Prevention/Infectious Diseases Society of America guidelines in 2023 following provider and radiology trainings compared with 2022 (63% [85 of 135] vs. 21% [20 of 95], P < 0.05)."*

The TB risk stratification work group consisted of the following individuals:

- NEMS TB PCP Champion
- SFDPH TB Controller
- California Department of Public Health TB Control Branch Chief/Infectious Disease Specialist
- UCSF Curry International TB Center Medical Director/Pulmonologist
- UCSF Pulmonologist/Implementation Science Expert
- UCSF Internist/Epidemiologist
- Kaiser Permanente Infectious Disease Specialist/HIV PCP/Research Scientist

The UCSF Curry International TB Center provided radiology training support by recruiting a UCSF TB/chest radiology specialist to review chest imaging with NEMS general radiologists.

Metrics

To determine the potential effect of new workflows on quality of TB evaluation, we extracted from the NEMS EHR the AFB sputum and MTB NAAT testing data from January 1, 2022, to December 31, 2023. Patients with three AFB smears and culture and at least one MTB NAAT completed were classified as complying with ATS/CDC/IDSA guidelines for TB diagnosis, the standard of care for TB evaluation. Patients with results indicating MTB detected in AFB culture

Table 2. A Comparison of Tuberculosis Sputum Tests Completed in 2022 (Preintervention) and 2023 (Postintervention)

Year	Unique Patients Undergoing Sputum Evaluation, N	Sputum AFB Smear and Culture Performed (at least once), n (N%)	MTB NAAT Performed, n (N%)	Complete Recommended Sputum Evaluation,* n (N%)
2022	95	84 (88%)	39 (41%)**	20 (21%)**
2023	135	124 (92%)	107 (79%)**	85 (63%)**

There was an increase in the number of individuals tested in 2023 compared with 2022 and a significant increase in the proportion of patients with complete American Thoracic Society (ATS)/Centers for Disease Control and Prevention (CDC)/Infectious Diseases Society of America (IDSA)–recommended sputum evaluation after the rollout of targeted trainings and test order colocation between 2022 and 2023. Chi-square testing was used to evaluate for an association between preintervention and postintervention periods and the number of active tuberculosis evaluations performed. AFB = acid-fast bacilli, MTB NAAT = mycobacterium tuberculosis nucleic acid amplification test. *MTB NAAT and AFB (both smear and culture) × 3 were completed as recommended by ATS/CDC/IDSA guidelines. **The *P* value is less than 0.05 (chi-square test). Source: The authors

and/or in MTB NAAT were classified as having confirmed active TB disease. Chi-square testing was used to evaluate for an association between the preintervention and postintervention periods and the number of active TB evaluations performed by (1) AFB sputum smear and culture, (2) MTB NAAT, and (3) complete guideline–based sputum evaluation (Table 2).

There was a statistically significant increase in the proportion of patients who completed all three AFB smears and culture as well as MTB NAATs per ATS/CDC/IDSA guidelines in 2023 following provider and radiology trainings compared with 2022 (63% [85 of 135] vs. 21% [20 of 95], $P < 0.05$) (Table 2). Improvements were seen throughout the process of TB diagnostic evaluation, with more sputum evaluations and appropriate microbiologic tests being ordered. Consults to the public health TB clinic for patients with chest imaging findings corresponding with negligible risk decreased between 2022 and 2023 according to qualitative feedback from SFDPH TB Clinic leadership. Of note, one active TB case was identified in 2022 and three active TB cases were identified in 2023 through PCP-initiated home TB sputum evaluation. Future analyses will include understanding the differences in processes of care for different chest imaging results, measuring the sustained improvement of this strategy on TB evaluation, and assessing the timeliness of the process.

Where to Start

- Identify a TB provider champion to foster a close partnership between community health center providers and public health departments.
- Play to the strengths of all partners and their capacities (e.g., the knowledge and expertise of public health practitioners and subspecialists as well as the systems thinking of community health center staff).
- Leverage existing tools; if EHR systems are available, consider how to optimize their use to facilitate clinical decision-making.
- Develop and adopt standardized language for radiologists to use in communicating the risk of findings to providers that supports provider decision-making in diagnosis of TB and LTBI.

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