

# Role of Chest Radiography in Diagnosing Pulmonary Tuberculosis, Does Every Suspected Case Needs GeneXpert MTB; A Cross-Sectional Study

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## Abstract

**Background:** Pulmonary tuberculosis (TB) triggers a common infection globally. Chest X-ray (CXR) plays a role in diagnosis of pulmonary TB and has typical findings. CXR is cost effective modality and can help to reduce the burden on health system if smear, culture, or rapid molecular tests are only done in patients where CXR shows suspicion of pulmonary TB.

**Objective:** To evaluate the diagnostic role of CXR versus standard GeneXpert MTB among adults suspecting pulmonary tuberculosis.

**Study type, settings & duration:** This cross sectional study carried out at Department of Radiology, Pakistan Institute of Medical sciences (PIMS), Islamabad from November 2023 to January 2024.

**Methodology:** CXR of symptomatic patients with and without findings consistent with Pulmonary TB were compared with GeneXpert MTB results for association between the results of two.

**Results:** The mean age of the participants was  $38 \pm 6.34$ . About 128 (75.74%) were male 41 (24.26%) were female. Out of total 169 CXR 47 (27.81%) had findings consistent with pulmonary TB of which 31 (65.96%) were detected as confirmed TB cases on GeneXpert. Those 122 (72.18%) which were not suspicious of pulmonary TB on CXR when tested for GeneXpert MTB showed positive results in 21 (12.42%) cases ( $p \leq 0.0001$ ). The Positive predictive value, Negative predictive value, sensitivity, and specificity were calculated to be 66.0%, 82.8%, 59.6% and 86.3% respectively.

**Conclusion:** CXR plays a vital role in the diagnosing adults with suspected active pulmonary tuberculosis by comparing with GeneXpert MTB in symptomatic patients.

**Key words:** Chest X-ray, tuberculosis, genexpert, diagnosis.

## Introduction

Chest X-ray (CXR) still has a vivacious role in diagnosing pulmonary TB and many doctors still rely on it for diagnosis.<sup>1</sup> According to World health organization (WHO) recommendations CXR

acts as an adjuvant test in smear negative TB.<sup>2</sup> Pulmonary TB is a common worldwide infection and has high death and sickness ratio specially in developing countries.<sup>3</sup>

Active tuberculosis is a condition in which Mycobacterium tuberculosis causes infection; typically, in the lungs, although many systems can be involved.<sup>4</sup> Any individual is suspected to have pulmonary TB considering symptoms or signs including productive cough for more than 2 weeks, which may be accompanied by other respiratory symptoms (shortness of breath, chest pains, haemoptysis) and/or constitutional symptoms (loss of appetite, weight loss, fever, night sweats, and fatigue).<sup>5,6</sup> GeneXpert MTB/RIF system is a fully automated real-time semi-nested PCR assay was endorsed as the most rapid test for diagnosis of pulmonary TB by WHO.<sup>7</sup>

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### Authors Contribution

MR, SK, AH & NK conceptualized the project and did the drafting, revision & writing of manuscript. SK, NK, MK & AK did the data collection. SK, MK & AK also did the literature search. SK & NK performed the statistical analysis.

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CXR of TB patients is classical with cavitation and upper lobe infiltrates but may be atypical.<sup>8</sup> One of the diagnostic procedure of TB is that CXR is done in all suspected cases and microscopy is only done in those cases where CXR shows pathology.<sup>9</sup> Diagnosing TB in young children is challenging due to non-specific presentation, microbiologic sample collection is difficult, and diagnostic uncertainty because of pauci-bacterial load, here CXR provides a valuable source to support the clinical diagnosis.<sup>10</sup> During incubation period of pulmonary MTB CXR is normal. Hilar or mediastinal lymphadenopathy may occur in addition to typical findings.<sup>11</sup> As per WHO standards GeneXpert MTB/RIF at present is the only rapid molecular test recommended for the quick diagnosis of tuberculosis.<sup>12</sup>

CXR helps to improve the sensitivity of TB screening approaches. The introduction of newer X-ray technology, less expensive equipment, and the findings of modern TB prevalence survey's which demonstrate the ability of CXR to detect asymptomatic people with TB have led to a renewed interest in mobile campaigns to screen people for TB. CXR can reduce the number of diagnostic tests needed because people with normal lung findings are unlikely to have pulmonary TB. CXR is also an important tool for diagnosing pulmonary TB in the absence of bacteriological evidence.<sup>13-17</sup>

It is necessary to assess the role of CXR as a diagnostic tool for pulmonary TB to identify cases of active pulmonary TB so that microscopy or molecular testing may only be done on strong suspicion based upon CXR. This will reduce the cost burden on patients and health system as well as waste of resources and unnecessary testing. Thus the aim of present study was to evaluate the diagnostic role of CXR versus standard GeneXpert MTB among adults suspecting pulmonary tuberculosis.

## Methodology

This cross sectional study was carried out at Department of Radiology, Pakistan Institute of Medical Sciences (PIMS), Islamabad over a period of 3 months from November 2023 to January 2024. Adult patients from 20 to 60 years of age and both genders were included in the study. Those having secondary TB or having any other pulmonary condition were excluded from the study, pregnant females and Patients having previous lung surgery were also excluded. All symptomatic patients suspected of having Pulmonary TB and referred to radiology department for CXR. All patients meeting the criteria during said period were asked to

participate in the study after taking informed written consent. The CXR of these symptomatic patients with suspected primary pulmonary TB was analyzed by classified radiologist and based on findings was reported as suspected TB or not. Pulmonary TB on CXR was labeled by radiologist based on the presence of lung parenchymal abnormalities including nodule(s), consolidation, and cavities. The presence or absence of pleural effusion and lymph node enlargement of the mediastinum or hilum was also recorded. The radiologist was blinded by sputum analyses reporting. Both suspected and not suspected on CXR underwent GeneXpert MTB analysis; The Xpert MTB/RIF assay is a fully automated molecular diagnostic test for TB disease. It can simultaneously detect *Mycobacterium tuberculosis* (MTB) complex DNA and mutations associated with rifampicin (RIF) resistance from sputum specimens in less than 2 hours, and it minimizes staff manipulation and biosafety risk. The results were compared with CXR findings to find if those suspected as pulmonary TB had positive GeneXpert MTB or not. The CXR findings and GeneXpert MTB reporting were compared and analyzed accordingly. Data entry and analysis were performed in SPSS version 25.0. Quantitative data like age was expressed in the form of mean  $\pm$  standard deviation. Demographic variables like gender was noted and presented in the form of frequency and percentages where applicable. The chi-square test for categorical data was used to find the comparison between CXR findings and GeneXpert MTB results. PPW, NPV, Sensitivity and Specificity were calculated. Data was stratified for age, gender, and results of CXR and GeneXpert MTB  $p$ -value  $\leq 0.05$  was taken as statistically significant.

The ethical approval was obtained from the Ethical Research Review Board of Pakistan Institute of Medical Sciences (PIMS), Islamabad vide letter no. F.3-1/2023(ERRB)/Chairman.

## Results

Mean age was calculated to be  $38 \pm 6.34$ . Out of 169 total patients included in our study 128 (75.74%) were male 41 (24.26%) were female as shown in Table-1. Out of total 169 CXR 47 (27.81%) were suspicious of, and findings were consistent with pulmonary TB. Of these 47 patients who were suspected as TB when sputum analysis for GeneXpert MTB was done, 31 (65.96%) showed positive result ( $p = 0.004$ ). Those 122 (72.18%) which were not suspicious of pulmonary TB on CXR when tested for GeneXpert MTB showed positive results in 21 (12.42%) cases ( $p \leq 0.0001$ ) as shown

in Table-2. Thus, there was a significant association between positive CXR findings and positive GeneXpert MTB results and vice versa. Cross tabulation for statistical analysis of the results was done as shown in Table-3. The diagnostic accuracy of CXR is shown in Table-4 with PPV, NPV, Sensitivity and specificity be 66%, 82.8%, 59.65 and 86.3% respectively.

**Table 1: Demographics of patient.**

| Demographics | N (%)        |
|--------------|--------------|
| Male         | 128 (75.74%) |
| Female       | 41 (24.26%)  |
| Age±SD       | 38±6.34      |

**Table 2: CXR and Sputum GeneXpert findings.**

| Results  | CXR<br>N (%) | Sputum GeneXpert MTB<br>N (%)                 | p-Value  |
|----------|--------------|-----------------------------------------------|----------|
| Positive | 47 (27.81)   | Positive: 31 (65.96)<br>Negative: 16 (34.04)  | < 0.0001 |
| Negative | 122 (72.18)  | Positive: 21 (12.42)<br>Negative: 101 (87.58) |          |
| Total    | 169 (100)    | 169 (100)                                     |          |

## Discussion

The role of CXR was determined in diagnosing pulmonary TB by comparing it with GeneXpert MTB which is considered as the gold standard rapid molecular diagnostic test for TB in this study. A meaningful association was found between the findings of both tests that denotes a pivotal role of CXR in diagnosing pulmonary TB. Nel et al.<sup>18</sup> in their research concluded that CXR remains the first investigation for the evaluation of pulmonary TB, especially in high burden areas which was consistent with present findings. Similarly, Miranda-Schaeubinger et al.<sup>19</sup> found that CXR is still the main investigation of choice in children for diagnosing pulmonary TB because it is easily available and cost effective. Nakiyingi et al.<sup>2</sup>

found that 51.1% of the CXR they interpreted as consistent with TB 29.4% of those had culture-confirmed TB, hence showing CXR has a role in diagnosing pulmonary TB. In the study by Kebede et al.<sup>20</sup>, clinicians in 69% and radiologists in 79% of culture confirmed cases suggested that CXR findings are consistent with findings of pulmonary TB. Thus, the literature is also proving a strong relationship between bacteriologically confirmed tuberculosis and CXR and concomitant to present findings. A study concluded that CXR should be done earlier in workup of pulmonary TB.<sup>21</sup> Another study concluded that CXR is a good predictor for PTB even in HIV-infected individuals.<sup>15</sup> If available, routine sputum culture and the World Health Organization-endorsed Xpert MTB/RIF assay should be implemented to achieve a more accurate diagnosis. It has also been concluded in a study that CXR is greatly useful in reducing the number of diagnostic tests needed even among presumptive TB patients.<sup>16</sup> Suspicious on CXR readings should be used to identify more people for TB testing which justified our results. In the research<sup>22</sup> the sensitivity, specificity positive and negative predictive values of CXR findings were 77.1%, 36.9%, 34.6% and 78.8% respectively concluding that in conditions where culture for MTB cannot be done easily CXR plays a vital role. These findings were similar to our findings though we used different methodology.

A study concluded that chest X-ray, one month after treatment initiation for TB was best for determining the final diagnosis in patients with suspected pulmonary TB.<sup>23</sup> Feyisa DW et al. in their study suggested that chest X-ray help in localization of pulmonary tuberculosis.<sup>24</sup> In the research by Nakiyingi L<sup>25</sup> the results showed that 29.4% of positive interpreted chest Xrays for TB actually had culture-confirmed TB while in our case it was 65.9%. Sensitivity and specificity of CXR interpretation in diagnosis of culture-positive TB were 67.9% (95%CI 56.6-77.8) and 53.7%

**Table 3: CXR and GeneXpert result cross tabulation.**

|       |                    |                    | GeneXpert |          | Total  |
|-------|--------------------|--------------------|-----------|----------|--------|
|       |                    |                    | Positive  | Negative |        |
| CXR   | Positive           | Count              | 31        | 16       | 47     |
|       |                    | % within CXR       | 66.0%     | 34.0%    | 100.0% |
|       |                    | % within GeneXpert | 59.6%     | 13.7%    | 27.8%  |
|       | Negative           | Count              | 21        | 101      | 122    |
|       |                    | % within CXR       | 17.2%     | 82.8%    | 100.0% |
|       |                    | % within GeneXpert | 40.4%     | 86.3%    | 72.2%  |
| Total | Count              |                    | 52        | 117      | 169    |
|       | % within CXR       |                    | 30.8%     | 69.2%    | 100.0% |
|       | % within GeneXpert |                    | 100.0%    | 100.0%   | 100.0% |

**Table 4: Diagnostic accuracy tests CXR.**

| Statistic                 | Value  | 95% CI           |
|---------------------------|--------|------------------|
| Sensitivity               | 59.62% | 45.10% to 72.99% |
| Specificity               | 86.32% | 78.74% to 91.98% |
| Positive Likelihood Ratio | 4.36   | 2.62 to 7.24     |
| Negative Likelihood Ratio | 0.47   | 0.33 to 0.66     |
| Disease prevalence        | 30.77% | 23.91% to 38.32% |
| Positive Predictive Value | 65.96% | 53.85% to 76.29% |
| Negative Predictive Value | 82.79% | 77.43% to 87.09% |
| Accuracy                  | 78.11% | 71.11% to 84.09  |

(95%CI 47.7-59.6) respectively, while in our case it was 59.62% (95%CI 45.10% to 72.99%) and 86.32% (95%CI 78.74% to 91.98%) thus contradicting with our findings of high specificity.

Present study had few limitations considering a small sample size and data was collected from a single hospital and reporting could have human error.

Present findings conclude that CXR plays a vital role in diagnosis of Pulmonary TB due to its high positive and negative predictive value, high specificity and sensitivity and low false positive and negative rate. Hence CXR before other tests could help us narrow down which patients required GeneXpert or other testing. Thus, this could be recommended that CXR should be the first investigation and should always be done before GeneXpert.

**Conflict of interest:** None declared.

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