

# Contact tracing/pre-employment screening for pulmonary tuberculosis: Should positive mantoux test necessitates routine chest X-ray?

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## Abstract

**Background:** Pulmonary tuberculosis (PTB) remains a scourge in most developing countries. Mantoux skin test and more commonly chest radiography are some of the methods of diagnosing the disease, especially with regard to contact tracing and pre-employment screening. Regular use of radiography has both safety and cost implications. This study aimed at establishing if any justification exists in requesting for chest radiographs in asymptomatic subjects with a positive Mantoux skin test reaction.

**Methods:** 174 adults comprising PTB contacts and newly employed/admitted university staff/students were recruited into the study. They were 89 males (51.1%) and 85 females (48.9%). All subjects had Mantoux test (using purified protein derivative, PPD). Patients who had positive Mantoux reaction subsequently were subjected to posteroanterior chest radiographic examination. Mantoux test and chest radiographic findings were then correlated with each other.

**Results:** 102 subjects (59.2%) had positive Mantoux reactions, while 27 subjects (31.1%) had abnormal chest radiographs. There was no significant correlation between Mantoux readings and chest radiographic findings ( $P=0.106$ ).

**Conclusion:** It is concluded that other ancillary tests like sputum examination and/or, where available, Interferon and ESAT tests should be carried out before chest radiograph is requested in subjects with positive Mantoux reaction.

**Keywords:** Chest radiography, contact tracing, mantoux test, pulmonary tuberculosis

## Résumé

**Arrière-plan:** Tuberculose pulmonaire (PTB) reste un fléau dans la plupart des pays en développement. Test cutané de Mantoux et plus généralement de radiographie thoracique sont quelques-unes des méthodes de diagnostic de la maladie, en particulier au regard de recherche des contacts et de dépistage préalable à l'emploi. Utilisation régulière de radiographie a des implications de sécurité et de coût. Cette étude visait à établir si toute justification existe en demandant des radiographies de poitrine dans des sujets asymptomatiques avec une réaction positive de test cutané Mantoux.

**Méthodes:** les adultes 174 comprenant des contacts PTB et nouvellement employés/admis personnel/étudiants ont été recrutés dans l'étude. Ils étaient les 89 hommes (51,1%) et les 85 femmes (48,9%). Tous les sujets avaient test Mantoux (à l'aide de dérivé protéique purifié, PPD). Les patients qui avaient par la suite de réaction positive de Mantoux étaient soumis à examen radiographique posteroanterior de poitrine. Conclusions radiographiques test Mantoux et à la poitrine étaient puis corrélées entre eux.

**Résultats:** 102 sujets (59,2%) avaient des réactions Mantoux positives, tandis que 27 sujets (31,1%) avaient des radiographies de poitrine anormale. Il n'y n'avait aucune corrélation entre les lectures Mantoux et conclusions de radiographie thoracique ( $P = 0.106$ ).

**Conclusion:** Il est conclu que les autres accessoires teste comme examen de salive et/ou, si cettedonnéestdisponible, tests interféron et ESAT doivent être effectuées avant lors de la poitrine est demandée dans les sujets avec la réaction positive de Mantoux.

**Mots-clés:** Radiographie thoracique, contact suivi, tuberculose pulmonaire, le test mantoux

## Introduction

Tuberculosis (TB) is a scourge in many countries, with higher incidence in the developing world.<sup>[1]</sup> It is a chronic infectious disease caused by *Mycobacterium tuberculosis*; a member of a group of closely related organisms in the *Mycobacteria complex* (*Mycobacterium africanum*, *Mycobacterium bovis*, *Mycobacterium microti* and *Mycobacterium tuberculosis*). One third of the world's population is reported to be infected with *Mycobacterium tuberculosis*.<sup>[2]</sup> TB is presently known to be a leading infectious cause of morbidity and mortality world wide.<sup>[3]</sup> It is a major health problem in Nigeria,<sup>[4]</sup> and has become more important with the advent of human immunodeficiency virus /acquired immunodeficiency syndrome ((HIV/AIDS) epidemic.<sup>[5]</sup> Infection with HIV is now known to be the most important risk factor for the development of tuberculosis in adults.<sup>[6]</sup>

Pre-employment screening of health care workers and contact tracing for pulmonary tuberculosis are well known and practiced widely.<sup>[7]</sup> These screening methods include tuberculin skin testing (Mantoux test), possibly with chest radiography, especially for subjects with a positive Mantoux reaction. A positive tuberculin reaction is regarded as a useful test in the epidemiological studies on the prevalence of tuberculosis, and it is regarded as a useful diagnostic aid in certain communities in individuals with suspected tuberculosis.<sup>[8]</sup> False negative tuberculin tests may be seen in military disease, tuberculous meningitis, protein-energy malnutrition and HIV/AIDS. However, there is no evidence that the immunosuppression found in pregnancy leads to false negative results.<sup>[9]</sup> Newer screening methods include blood tests such as the Interferon Gamma Release Assays (IGRAs), for example, T- SPOT. TB Test. The principle of this test is the detection of effector T- cells that respond to stimulation by *M. tuberculosis* antigens (ESAT-6 and CFP 10) by capturing interferon gamma (IFN- $\gamma$ ) in the vicinity of T- cells from which it was secreted. It is estimated to have a sensitivity of 71% in a survey carried out in Banjul, Gambia.<sup>[10]</sup> Mantoux test, however, is of very little diagnostic value in screening for pulmonary tuberculosis in Nigeria, as BCG (Bacille Calmette Guerin) is given at birth to many children; this is in contrast to what is obtained in the developed world where BCG is not given at birth. The environmental mycobacterium species in the tropics also influence this test. As mentioned earlier, immunosuppressive states like HIV

infection and malnutrition may also limit its usefulness.

It is also worthy of note that there is paucity of information indicating the yield of abnormal chest radiographic findings for significant Mantoux reactions in otherwise asymptomatic individuals. There is thus a compelling need to evaluate the place of pre-employment screening/contact tracing procedure in developing countries.

This study, therefore, aimed at determining the relevance of chest radiograph requests following a positive Mantoux reaction. This is particularly important when it is realized that routine chest radiography has both economic and safety (exposure to ionising radiation) implications.

## Materials and Methods

One hundred and seventy four adults, comprising fresh university students, newly employed staff and patients referred for Mantoux test on account of contract tracing for PTB, were recruited into the study. Approval of the Hospital's Ethical Committee was sought and obtained. The initial screening consisted of Mantoux test, using Purified Protein Derivative (PPD-5TU). About 0.1 ml of the solution was injected intradermally over the flexor aspect of the forearm with a 26-gauge needle. The test was read after 72 h and the size of the reaction (read across the induration) was classified as follows: negative (0-4mm), intermediate (5-9mm), positive (10mm or more). Each subject who had a positive Mantoux test subsequently underwent chest radiographic examination.

The chest radiograph was a posteroanterior (PA) exposure, taken during full inspiration with a Roentgen 301 machine (GE Medical), using the following factors:  $kV P=65$ ;  $focus-film\ distance=150cm$  and  $mAs=12-15$ . Each radiograph was assessed by one of the authors (A.A) with emphasis on the lung fields for infiltrates, consolidation or cavitations that would suggest lung parenchymal disease. The radiographs were then classified as normal or abnormal.

Data handling and statistics was done using the SPSS software (version 13). Frequency tables, contingency tables and charts were drawn to express the results. Statistical tests of hypothesis such as Chi-square test and ANOVA were used to assess non-association between two variables where appropriate. Observed parameters (Mantoux reading, chest radiographic

findings) were correlated with each other and with other variables such as age and body mass index (BMI). A *P* value less than 0.05 was considered as significant.

## Results

Subjects studied were aged between 10 and 86 years. The mean age of the subjects was  $28.3 \pm 15.8$  years. The median and modal ages were 27 and 25 years, respectively, as shown in Table 1. 98 (56.3%) subjects were of normal body mass index; twenty-five (14.4%) were underweight, while forty-four (25.3%) were overweight.

102 (59.2%) subjects had positive ( $\geq 10$ mm) Mantoux test, while 58 (33.3%) and 12 (6.9%) had intermediate (5-9mm), and negative (0-4mm) readings, respectively. The mean Mantoux test reading for all the subjects was  $9.9 \pm 4.1$ mm; within a range of 0 to 28 mm, as depicted in Table 2. The mean Mantoux reading for age group 10-20 years was  $7.32 \pm 4.53$  mm, while the reading for those aged 80 years and above was  $12.50 \pm 1.80$ mm. [Table 3] Analysis of variance showed a statistically significant difference in the mean Mantoux readings for the various age groups ( $f = 4.382$ ,  $P = 0.002$ ). Age correlated well with Mantoux test readings such that, with increasing age, there was increasing positivity of Mantoux test ( $r = 0.21$ ,  $P = 0.006$ ).

53 males or 60.2% and 50 females or 58.8% had positive Mantoux readings. However, positive Mantoux finding between the genders was not statistically significant. ( $P=0.851$ ). 146 (83.9%) subjects had normal chest X-ray findings, while 27 (15.5%) had abnormal findings. This is shown in Table 4. Two subjects did not complete the study.

Mantoux test did not have any statistically significant relationship with abnormal chest radiological findings ( $P = 0.087$ ); as could be seen in Table 5. Those with positive Mantoux had more cases of normal radiological findings than those that were found to be negative.

## Discussion

The purified protein derivative (PPD), Mantoux or tuberculin tests remain a common screening method for pulmonary tuberculosis worldwide.<sup>[11,12]</sup> However, uncertainty remains about its role in routine pre-employment screening/contact tracing for the detection of tuberculosis.<sup>[7]</sup> This is especially so when newer more sensitive tests, like the Interferon gamma Release Assays (IGRAs), with sensitivity values up to 71%, have been developed.<sup>[9]</sup>

**Table 1: Age group distribution of subjects**

Group (years)	Frequency	Percentage
Valid <20	33	18.9
20-39	111	63.8
40-59	18	24.3
60-79	7	04.2
>80	5	02.8
	174	100.0

**Table 2: Mantoux finding among subjects**

Reading	Frequency	Percentage
0-4 mm	12	06.9
5-9 mm	58	33.6
>10 mm	103	59.5
Total	173	100.0

**Table 3: Age group mantoux findings**

Group (years)	Mantoux reading			Total
	0-4 mm	5-9 mm	> 10 mm	
<20	7	15	11	33
20-39	4	33	73	11
40-59	1	6	12	19
60-79	0	3	4	7
>80	1	0	3	4
	15	57	103	173

**Table 4: Chest radiographic findings**

Age group years	Chest radiographic findings		Total
	Normal	Abnormal	
<20	25	7	32
20-39	104	7	111
40-59	10	7	17
60-79	3	5	7
80 and above	2	1	2
Total	142	27	172

**Table 5: Chi-square of mantoux findings against chest radiographic findings**

Mantoux finding	Chest radiograph finding		Total
	Normal	Abnormal	
0-4 mm	8	4	12
5-9 mm	47	11	58
>10 mm	90	12	102
Total	145	27	172

$\chi^2 = 4.481$ ;  $df = 2$ ;  $P = 0.106$

These tests are expensive and not readily available in our environment for routine use.

There have been previous studies that suggested the superiority of radiographic screening over Mantoux skin testing for pulmonary tuberculosis.<sup>[13]</sup> Considering the attendant radiation exposure and cost of routine chest radiography, it

is worthwhile to determine the benefits (if any) of chest radiographic examination for patients who react positively to Mantoux tests.

The higher number of subjects with positive Mantoux reaction in this report (about sixty percent) is slightly lower than figures from some other developing countries, and other parts of Nigeria.<sup>[14-16]</sup> This could be partly due to the higher sample size in those studies compared with the present one. Probably, the different figures obtained from different studies have led some observers to doubt the value of Mantoux test in the diagnosis of pulmonary tuberculosis.<sup>[17]</sup>

This study found increasing positivity to Mantoux test with increasing age, and this is in agreement with the previous works on Mantoux test on Nigerian adults.<sup>[14,15]</sup> The explanation for this probably lies in routine BCG vaccination at birth, as well as exposure over the years to the tubercle bacilli of these subjects.

There have been reports showing that in suspected tuberculosis contacts, chest radiographic abnormalities are rare and are not predicted by testing Tuberculin skin reactivity.<sup>[18]</sup> It has been also noted that radiographic features may be non-specific, especially in patients with low CD<sub>4</sub> cell count.<sup>[6]</sup> Tancja and others,<sup>[19]</sup> in their study on tuberculous screening for trauma admissions found only one case of chest radiographic abnormality out of fifteen patients with positive Mantoux reaction. Egbagbe and colleagues,<sup>[14]</sup> found no chest radiographic evidence of active tuberculosis out of 26 controls that had strongly positive Mantoux reactions. Our observation in this study also is a very low concordance rate between abnormal chest radiographic findings and Mantoux positivity.

The probable implication of this is that sizeable number of our population are exposed to the tubercle bacilli without developing lung parenchymal disease, and therefore will show a positive, Mantoux reaction with normal chest radiographs. This therefore suggests that there may not be a need for follow-up chest radiograph for every case of asymptomatic positive Mantoux reaction. Other tests like sputum microscopy, which can identify about 35% of subjects with tuberculous disease,<sup>[20]</sup> gastric aspirate or more sensitive tests like the IGRAs may have to be considered before chest radiography is resorted to.

## Conclusion

The study found a low correlation between abnormal chest X-ray findings and positive reactions to

Mantoux testing in asymptomatic subjects. In view of the economic and safety implications of routine chest radiographic examination, more sensitive tests like IGRAs/ESAT-6 are recommended for screening before chest radiography. This is in order to detect the cases whose positive readings could be followed by chest radiographic examinations.

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