Original article

Sensitivity of chest X-rays and their relation to sputum results in the diagnosis of pulmonary tuberculosis in Hosanna Hospital.

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Abstract: A retrospective analysis of records of Tuberculosis (TB) patients from Hossana Hospital was done from May to July 1994 to assess the relationship of chest radiographic patterns and the likelihood of finding Acid Fast Bacilli (AFB) in sputum smears done for pulmonary TB patients. The sputum results, clinical diagnosis, and other demographic variables were obtained from the hospital tuberculosis register. The chest-X Ray (CXR) findings of each patient were reviewed by a radiologist. A total of 352 hospital records with sputum and CXR results were included in the study and 43.8% and 66.2% of the patients had positive smear results for AFB and CXR suggestive for pulmonary TB, respectively. Among the major CXR findings, cases with cavity, interstitial shadowing, and lung collapse showed over 50% smear positivity. In this study it is noted that the CXR was used for all suspects of TB which resulted in an increased cost for routine diagnosis. The use of the flow sheet for the diagnosis of pulmonary TB and to use additional clinical tools is recommanded if the need arises. [*Ethiop. J. Health Dev.* 2000;14(2):199-204]

Introduction

The magnitude of the global tuberculosis (TB) problem is enormous. According to a recent estimate, approximately 90 million new cases of TB would occur worldwide during the decade 1990 through 1999. Among adults, TB is the world's foremost cause of death from a single infectious agent. If global control of TB remains at the level of the previous decade, 30 million people were expected to die of this disease by the year 2000 (1). In 1996 alone 3.8 million new cases of TB were reported to the World Health Organization (WHO), but it is estimated that between seven and eight million cases might have occurred worldwide. Over 95% of these cases occurred in developing countries (2).

TB has declined in industrialized countries during the past decades, but it still represents a major health problem in low-income countries. In these countries several problems, such as overall poor health and poor socioeconomic status of the population as well as other factors create extraordinary challenges for the running of a proper TB control program. For TB control purposes in low income countries, a case of TB is defined as an individual discharging TB bacilli, especially if the sputum smear can be shown by direct microscopy to contain Acid Fast bacilli (AFB) (3). Therefore, the diagnosis of pulmonary TB is based on bacteriological examination of sputum smears (4).

The traditional model of medical history, clinical examination, and sputum smear microscopy has proved capable of detecting the majority of infectious TB cases and, in conjunction with adequate case finding and treatment, the model remains the backbone of TB control.

Radiological diagnosis of TB is unreliable, since many other lung diseases may mimic the picture of pulmonary Tb (3). In addition, the cost of radiographic examination is high and

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very often not affordable for all cases of TB in low-income countries (5). The use of chest X-ray (CXR) for all cases suspected of pulmonary TB should be discouraged as this frequently leads to shortage of X-ray films for other vital purposes. CXR does not appear to be a good alternative method for the diagnosis of TB since, although the method is sensitive, it is at the same time not specific. Furthermore, it is even less specific and may also be less sensitive in the diagnosis of HIV-associated TB (6). Radiographs can, however, be very helpful, especially for the diagnosis of TB in children (where sputum is frequently negative), miliary TB, smear negative pulmonary TB, and extra pulmonary TB. In individuals clinically suspected of having pulmonary TB but with negative sputum smears, a CXR examination should always be made by an experienced medical officer in order to avoid misclassification and mistreatment of TB (6).

During the time of the study, in most hospitals and health institutions in Ethiopia, any individual suspected of suffering from pulmonary TB will receive a CXR examination, have routine hematological investigations, and erythrocyte sedimentation rate (ESR) as well as his/her sputum is examined for the presence of AFB using standard microscopy (personal observation).

The Ethiopian TB Control Program Review by the World Health Organization (WHO) during July 11-23, 1994 pointed out that patients are commonly diagnosed at hospitals where there is an over emphasis on CXR and over diagnosis of smear negative cases (7). There is thus a need to critically evaluate the use of chest radiography in the routine management of TB in this country.

The aim of the present study was to evaluate the relationship of chest radiographic patterns and the likelihood of finding AFB in sputum smears done for pulmonary TB patients in order to minimize the routine use of CXR for pulmonary TB suspects in Ethiopia.

Methods

The study was done in Hosanna, 230 km southwest of Addis Ababa, in the Southern Nations Nationalities and Peoples Region (SNNPR), Ethiopia. The hospital has 150 beds. In 1994, 2854 patients were diagnosed as cases of TB in the hospital, of which 233 were admitted and 42 died. Before the introduction of a flow sheet (Fig. 1) for the diagnosis of pulmonary TB in late 1994, all suspects were examined for AFB presence in the sputum, CXR and routine Hematological tests as well as ESR.

Hospital records of all patients who had been diagnosed as cases of pulmonary tuberculosis at Hosanna Hospital form May to July 1994 were reviewed. For each suspect three sputa samples were collected and processed using the Zehil Nelson's staining technique. For the purpose of routine radiological diagnosis of tuberculosis a posterio-anterior view CXR was used in the hospital. The sputum results and demographic variables such as age and sex were obtained from the hospital tuberculosis register. The chest radiograph of each patient was reviewed by a radiologist who had no knowledge of the sputum result or the clinical diagnosis. The CXR findings were classified as 'yes' for those having an upper lobe and/or miliary pattern, 'suspicious' for those with findings other than apical and/or upper lobe of the lung, and 'no' for those with normal CXR or findings consistent with diagnosis other than pulmonary TB. The presence of pleural effusion, lung collapse, cavity, alveolar opacity, interstitial shadowing, hilar lymphadenopathy and pleural thickening were added together to create a new variable "SCORE". Each radiological finding was graded as 1 and 2 to show the absence and presence, respectively. Data were entered into microcomputer and analyzed using EPI-INFO version 5.01 software package.

Results

A total of 352 hospital records were available for this study. Table 1 summarizes the distribution of patients by selected demo-

graphic variable. Of the 352 patients 226 (64.2%) were males. The mean age was 25.7 years with a standard deviation of 11.8 years and an age range of 10 to 80 years. Of these patients 43.8% had a positive smear result for acid fast bacilli. The highest numbers of smear positive cases were between the ages of 15 and 44. Two hundred thirty three (66.2%) of the patients had chest radiographic findings suggestive of pulmonary TB.

Table 1: **Distribution of pulmonary tuberculosis patients, by selected variables, Hossana, 1994.**

Variable	Number	Percent
Age group		
0-14	47	13.4
15-24	128	36.4
25-34	101	28.7
35-44	49	13.9
45-54	19	5.4
55-64	6	1.7
65+	2	0.6
Sex		
Female	126	35.8
Male	226	64.2
Sputum result		
Negative	198	56.3
Positive	154	43.8
CXR finding suggestive for pulmonary tuberculosis		
No	37	10.5
Suspicious	82	23.3
Yes	233	66.2

The major chest radiographic findings are summarized in Table 2, of which cavity, interstitial shadowing, and lung collapse showed smear positivity in more than half of the cases. Among the radiographic findings categorized as "other findings", wide spread micro nodular shadowing, honey-comb shadowing, vascular congestion, and cardiac enlargement, bilateral basal patchy alveolar opacity, and hilar emphasis were the most frequent ones. Of the 19 patients under "other findings" with miliary presentation on CXR, 17 (90%) were suggestive for miliary TB, 13 (68%) with smear negativity and two were with other diagnosis. Examination of radiographic films of patients whose chest radiographs did not have any findings suggestive for TB showed that 15 (43.2%) of these films were normal chest radiographs (Table 3).

Table 2: **Distribution of major CXR findings, Hosanna, 1994.**

CXR finding	Number	Percent
Pleural effusion		
Yes	46	13.1
No	306	86.9
Lung collapse		
Yes	37	10.5
No	315	89.5
Cavity		
Yes	154	43.7
No	298	56.3
Alveolar opacity		
Yes	74	21.0
No	278	79.0
Interstitial shadowing		
Yes	173	49.1
No	179	50.9
Hilar lymphadenopathy		
Yes	25	7.1
No	327	92.9
Pleural thickening		
Yes	18	5.1
No	334	94.9
Other findings		
Yes	74	21.0
No	278	79.0
Normal CXR		
Yes	15	4.3
No	337	95.7

Only one of these patients with normal chest radiograph was shown to have AFB upon sputum smear examination. As shown in Table 4, cavity and interstitial shadowing were positively associated with positive AFB smear result while pleural effusion and normal CXR were negatively associated with positive AFB smear result ($P<0.01$). The presence of different findings added together as a score ranged from a minimum of seven to a maximum score of 14. Those cases having

Table 3: **Radiological diagnosis in patients with no CXR findings suggestive for tuberculosis, Hosanna, 1994.**

Diabnosis	Number	Percent
Pneumonia other than tuberculosis	4	10.8
congestive heart failure	7	19.0
Bronchiectasis	3	8.1
Interstitial lung disease	3	8.1
Lung abscess secondary to bacterial infection	2	5.4
Malignancy	1	2.7
Elevated hemi-diaphragms	1	2.7
Normal CXR	15	43.2

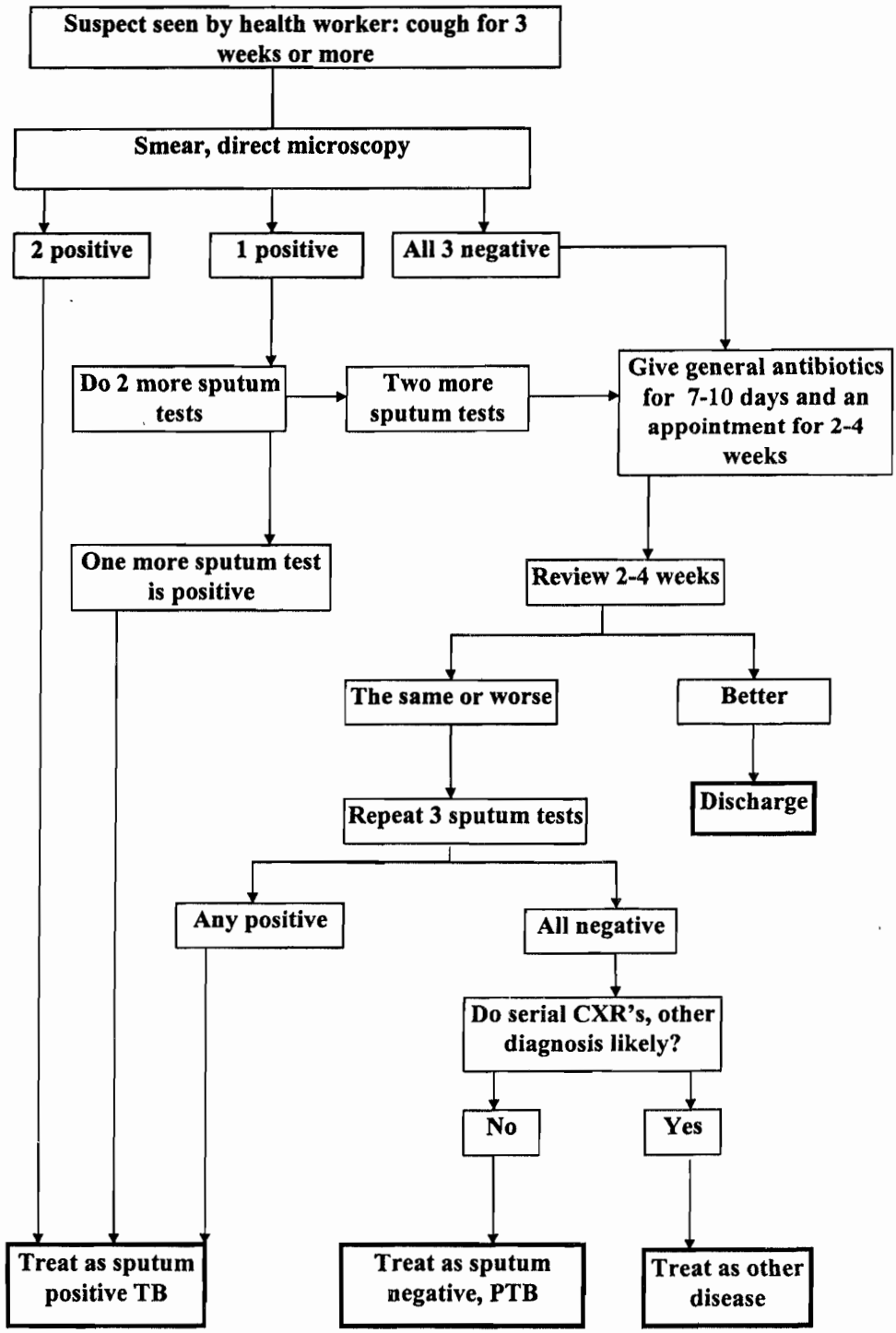

Figure 1: Flow sheet for the diagnosis of pulmonary TB (Source: MOH for the National Tuberculosis and Leprosy control Program in Ethiopia, 1997)

Table 4: **CXR findings and AFB sputum smear results in pulmonary tuberculosis, Hossana, 1994**

CXR finding	AFB smear result		Rlative risk	95% CI
	Positive (%)	Negative (%)		
Cavity				
Present	104(67.5)	50(25.3)	2.67	2.05 - 3.48***
Absent	50(32.0)	148(74.7)		
Interstitial shadowing				
Present	107 (69.5)	66(33.3)	2.36	1.79 - 3.09***
Absent	47(30.5)	132(66.7)		
Pleural effusion				
Present	10(6.5)	36(18.2)	0.46	0.26 - 0.81**
Absent	144(93.5)	162(81.8)		
Normal CXR				
Yes	1 (0.6)	14(7.1)	6.81	1.02 - 45.40**
No	153(99.4)	184(92.9)		
Score				
7	5(3.2)	42(21.2)		
8	43(27.9)	79(39.9)	3.31	1.40 - 7.85**
9	86(55.8)	60(30.3)	5.54	2.39 - 12.82***
10	19(12.3)	16(8.1)	5.10	2.11 - 12.33***
11	1(0.6)	1(0.5)	4.70	0.94 - 23.62NS

*** = P<0.001, ** = P<0.01, * = P<0.05, NS = Not Significant

more than one finding on CXR were significantly associated (P<0.001) with positive AFB result.

Discussion

In this study, out of all patients, 43.8% had AFB seen on sputum smear. Similar studies noted findings ranging from 41% (8) to 82% (9). The lower percentage in our case may be described to a less extensive disease and a lower sensitivity of direct microscopy using Ziehl Neelsen Staining method compared to culture and fluorescent microscopy in the other studies. The highest number of smear positive cases in the age group of 15-44 is consistent with the findings of control programs as evidenced by their routine quarterly reports. In over 67% of the cases with cavity, the AFB result was positive. Cavitation has been known to be one of the characteristics of pulmonary TB (10). Cavities may be single or multiple, usually occurring in characteristic sites: apical segment of lower lobe or apical/posterior segment of an upper lobe. Characteristically the surrounding tissue shows evidence of consolidation (alveolar opacity), fibrosis (interstitial opacity), and areas of calcification. In untreated cases the sputum is invariably positive for AFB (10). In those with lung collapse, 56.7% of smear positivity can be attributed to the presence of additional CXR findings such as cavity and interstitial shadowing. Tuberculosis may cause lung collapse by various mechanisms such as: endobronchial obstruction, bronchostenosis in people with advanced fibrocaseous cavitary diseases, and extrinsic pressure by enlarged lymph nodes. Sputum tests are of limited value in lung collapse as the expectorated material often arises from the non-atelectatic (Non-collapsed) areas and may not reflect the disease process which has produced the bronchial obstruction (10).

Pleural effusion occurred in 13.1% of the patients, which is similar to the findings of Farman DP and Speir WA (11). Of the total patients with pleural effusion, 21.7% had positive sputum smear for AFB, which showed a significant association (RR=0.46, 95%CI = 0.26-081,P<0.01). The negative relationship of pleural effusion with positive sputum smear result can be related to the presence of pleural TB or other pathology other than pulmonary

TB. Pleurisy with effusion is a common initial manifestation of intra-thoracic tuberculosis in children and young adults (10). Intra-pulmonary lesions are usually not demonstrable on CXR. The effusion is usually unilateral and seldom massive. Sputum cultures are usually negative. Sometimes pleural effusion may be a secondary complication of active pulmonary TB, in which case the intra-pulmonary lesions are easily demonstrable on CXR and sputum cultures are usually positive (10). In view of individual cases one of the major causes of pleural effusion is TB (Pleural TB or late complication of pulmonary TB). When we consider the epidemiological importance, it is not mainly associated with those cases which discharge AFB and useful for control purposes. Therefore, the priority in case findings should be for cases to be identified by direct microscopy.

Out of the 37 patients with CXR not suggestive for pulmonary TB but clinically suspected (Table-1), one turned positive on sputum test for AFB. In this case the presence of normal CXR and a positive sputum result shows minimal TB. Similar findings were documented from other studies (11,12). These patients could conceivably represent primary tuberculosis with a very minute focus of infection, or they may represent reactivation TB with subradiographic pulmonary lesions. Therefore, a normal CXR does not exclude the presence of pulmonary TB.

The positive sputum result in cases with multiple CXR findings can be attributed to the presence of more extensive diseases involving most parts of the lung (12). Even if, in the majority of the cases, AFB is negative, finding a miliary pattern on CXR should be taken as a consideration for the diagnosis of TB in addition to clinical findings. Miliary lesions vary from one to four mms and are fairly discrete. The lesions are distributed uniformly throughout the lung, including apices. In some cases pleural effusion or the presence of chronic fibrocavitary apical lesions may be noted. Fever, chills, and maliase are usually present but cough and expectoration may be minimal and positive sputum cultures may be difficult to obtain (10). According to the flow sheet (Figure 1) for the diagnosis of pulmonary TB, there is no need of routine CXR for those cases which turned positive on AFB sputum smear. In this study, all patients had routine CXR in spite of their sputum results which show an over use of CXR. The money invested on CXR of 154 smear positive cases, which is estimated to be around 2000 Birr (320 USD)[1], could be used for 1600 patients sputum smear analysis.

Even though the study was limited to the analysis of records, it showed that CXR was used for all suspects of tuberculosis that ended up in an increased cost for routine diagnosis. In addition, as evidenced elsewhere, it can increase the risk of individuals and population radiation exposure (13). From the CXR presentation, cavity, interstitial shadowing and the presence of more than one findings were found to be positively associated with positive sputum smear. Considering the occurrence of atypical CXR findings associated with different health problems, the cost and the risk of radiation exposure, it is recommended to use sputum smear for AFB as a primary diagnostic tool for pulmonary TB. Therefore, it will be necessary to use the flow sheet (Figure-1) for diagnosis of pulmonary tuberculosis in control programs and clinical management tools in difficult individual cases in addition to the flow sheet.

[1]Assumption 1 CXR costs around 12 Birr
1 USD is around 6.29 Birr (1995)
1 sputum analysis costs around 0.2 USD

Acknowledgement
We are grateful to the Hossana Hospital TB Clinic staffs for their continuous support in collecting the data for the study.

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