Risk Factors Affecting the Development of Tuberculosis Infection and Disease in Household Contacts of Patients with Pulmonary Tuberculosis

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Abstract

Objective: The aim of this study was to investigate the incidence of tuberculosis and factors effecting development of tuberculosis in household contact individuals with pulmonary tuberculosis patients.

Methods: The total number of recorded in-house contacts of 153 pulmonary tuberculosis patients was 625 patients came to control and were documented for treatment and follow up in Istanbul Eyup Tuberculosis Dispensary between January 2001 and December 2002.

Results: Tuberculosis was detected in 35 (5.6%) household contacts. The incidence of tuberculosis in household contacts was found to be related with the presence of cavity in tuberculosis patient (7.4% in patients with cavity, and 2.6% in patients without cavity, p<0.05). Mean TST positivity rate of household contacts under 15 years old was higher in cases whose index case had cavity and positive sputum AFB than cases whose index case had no cavity and negative sputum AFB (p<0.05).

Conclusion: These household contacts with pulmonary tuberculosis patients having cavity and smear positive, are the most risky group for tuberculosis contamination, and are the easiest group to detect tuberculosis. Close follow up of household contacts of such patients for tuberculosis is important for tuberculosis

Key words: Pulmonary tuberculosis, household, contact, examination, risk factor

INTRODUCTION

Although tuberculosis (TB) is a treatable disease, every day 5 thousand people die because of this disease [1]. More than 90% of TB cases and deaths occur in developing countries and 75% of these cases are between 15 and 54 years old that is economically the most productive age group [2].

TB is an infection that is usually transmitted by inhalation of droplet nuclei [3]. A case with active TB may infect an average of 10-15 people annually [1]. Environments with poor ventilation and crowded populations such as prisons, refugee camps, nursing homes, schools, crowded families increase the contamination risk [4]. Household contacts present in these environments are under high risk for infection and TB disease.

Tuberculosis Dispensaries in Turkey do the follow up of the treatment of tuberculosis patients. Tuberculosis Dispensaries are present nearly in all regions the country. In these dispensaries chest x rays are obtained for patients who has respiratory complaints and for patients who applied for health report to start a new job. The sputum examination and culture are done in patients tuberculosis suspected due to clinical and radiological findings. The patients who needed further evaluation were sent to chest disease hospitals. The physical examinations, investigations and follow up of the tuberculosis contacts are also done in these dispensaries.

In this study we aimed to determine the frequency of TB development in household contacts of TB cases and factors effecting this development.

MATERIALS AND METHODS

Study Subjects

In this study in formations of the participants were evaluated retrospectively from the file records. The total number of recorded in-house contacts of 153 pulmonary tuberculosis patients was 753 of whom 625 patients came to control and were documented for treatment and follow up in Istanbul Eyup Tuberculosis Dispensary between January 2001 and December 2002. The gender, age, occupation, closeness to index case, number of control they came, the diagnosis of household contacts and BCG scar, tuberculin skin test (TST) results, prevention therapy given or not, the period of prevention therapy in household contacts fewer than 15 were recorded. The relationship between TB frequency in household contacts and gender, age, bacteriological properties of index case, radiological degree of the disease and presence of cavity was evaluated. The follow-ups of the household contacts were done in three months periods. The household contacts who did not come any of the follow ups were not included to study. The contacts came to controls at least once were taken to study. Index tuberculosis cases were consisted of smear positive and smear negative pulmonary tuberculosis cases. All of the contacts were comprised of household contacts. Household contacts included spouse, child, mother-father, brother/sister and other parents

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(such as uncle, grandfather, cousin). The definitions used for case were done according to WHO guideline [2].

Household contacts above 15 years old were evaluated by obtaining a microfilm in every control. Acid Fast Bacilli (AFB) in sputum examination was searched 3 times in cases who had complaints and whose microfilms revealed suspicious lesion. Child cases or household contacts who needed advance search, were sent to chest disease hospitals. TB diagnosis of the contacts was done bacteriologically in our dispensary or in hospitals they were sent. All cases who thought to have extrapulmonary organ TB were sent to hospital. Their diagnosis was done in hospitals. The household contacts under 15 years old who did not have TB, received INH prophylaxis for 6 months.

Tuberculin skin test

In Turkey, since recent times, prophylaxis has been given to close contacts younger than 15 years old. Now, prophylaxis is applied to close contacts under 35 years old (if not ill). For this reason, at the time of study, tuberculin skin test (TST) was being performed only in close contacts under 15 years old. TST was performed and lung microfilms were obtained from household contacts under 15 years old during controls. Five TU of PPD - RT23 with Tween 80 was performed into 1/3 upper lateral region of the left forearm for TST and induration diameter was read 72 hours later. For standardization of test the same person interpreted it. The interpretation of TST reaction was done as follows: in cases with BCG; 0-5 mm negative, 6-14 mm due to BCG, 15 mm and above positive. In cases without BCG; 0-5 mm negative, 6-9 mm suspicious so it was repeated 1 week later, if again 6-9 mm it was accepted as negative, 10 mm and above was accepted as positive. If the result of first test was 10 mm or above it was thought to be positive in immune deficient cases 5mm and above were accepted as positive.

Radiological Extent

The extension of lesions in the chest radiograph of the index case was divided into two groups. The lesions were defined as follows: Moderate degree lesion; total diameter of the cavities was less than 4 cm or sum of the homogen lesions was less than 1/3 of one lung area or sum of the dispersed infiltrations was less than a lung area. Severe degree lesion; total diameter of the cavities was more than 4 cm or sum of the homogen lesions was more than 1/3 of one lung area or sum of the dispersed infiltrations was more than a lung area.

Statistical Analysis

Statistical analyses were done using SPSS version 12 (SPSS Inc, Chicago, IL). Chi-square test was used to compare groups, and t test and ANOVA test were used to analyze numerical variables. To compare the effect of AFB positivity of index case on mean TST reaction in cases younger than 15 years old Mann Whitney test was used. Logistic regression was used to investigate the association of two or more independent or predictor variables with a two-category (binary) outcome variable. P values below 0.05 were considered significant.

RESULTS

The demographic characteristics of the contacts were shown in table 1. The mean age of contacts determined active disease was 24.4 ± 16.9. Twenty-one of them were female and 14 male. The mean age of index cases was 33.8 ± 14.3 (16-88). Thirty-seven of these cases were female and 116 male. Of the contacts 191 (30%) were 15 years old or below. PPD was applied 153 (80%) of them. Mean PPD value was 11.8 ± 7.8 mm and INH prophylaxis was given 150 (79%) of them. TB was diagnosed in 35 (5.6%) cases (Table 2). No relationship was found between TB frequency of contacts and gender, age, closeness to the index case, AFB positivity of the index case and radiological degree of the disease. Only a relationship between presence of cavity in index case and TB frequency in contacts was found (7.4% in cases with cavity, 2.6% in cases with no cavity, p<0.05) (Table 3).

No relationship was found between TST positivity of contacts and gender, age, closeness to the index case, BCG scar presence and radiological degree of the disease of index case. The rate of TST positivity of household contacts under 15 years old was higher in cases whose index case had cavity and positive sputum AFB than cases whose index case had no cavity and negative sputum AFB (p<0.05) (Table 4).

Table 1. Demographic characteristics of household contacts

Mean age	26.7 ± 18.0
Mean control number	1.51 ± 0.77
Gender	
Female	344 (55%)
Male	281 (45%)
Closeness degree to index case	
Spouse	67 (10.7%)
Child	136 (21.8%)
Mother-father-sibling	238 (38.1%)
Parent	182 (29.1%)
Non parent	2 (0.3%)

Table 2. Tuberculosis frequency in household contacts

	n (%)
Normal	578 (92.5)
Old inactive	12 (1.9)
Smear (+) pulmonary tb	15 (2.4)
Smear (-) pulmonary tb	11 (1.7)
Tuberculosis pleurisy	8 (1.3)
Tuberculosis lymphadenitis	1 (0.2)
Total tuberculosis	35 (5.6)

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Table 3. Factors associated with tuberculosis frequency in household contacts

	Number of contacts	Tuberculosis cases among contacts n (%)
All cases	625	35 (5.6)
Gender		
Male	281	14 (5.0)
Female	344	21 (6.1)
Year		
2001	265	17 (6.4)
2002	360	18 (5.0)
AFB status of index case		
Positive	513	27 (5.3)
Negative	112	8 (7.1)
Radiological extension in PA graph of index case		
Moderate	459	25 (5.4)
Severe	166	10 (6.0)
Presence of cavity in PA graph of index case		
Absent	232	6 (2.6)
Present	393	29 (7.4)*

* p<0.05, compare to cavity absent cases

Table 4. Factors associated with mean TST reaction in household contacts less than 15 years old

	Number of contacts	Mean TST (mm)	TST (Positive) n (%)
All cases	153	11.7 ± 7.8	63 (41.2)
Gender			
Male	93	11.5 ± 7.5	38 (40.9)
Female	60	12.2 ± 8.2	25 (41.7)
Age group			
0-5	63	11.8 ± 8.3	26 (41.3)
6-10	59	11.2 ± 7.8	23 (39)
11-14	31	12.6 ± 7.0	14 (45.2)
BCG scar			
Presence	148	11.8 ± 7.8	60 (41.2)
Absence	5	6.2 ± 8.7	2 (40.0)
AFB status of index case			
Positive	133	12.5 ± 7.5*	60 (44.8)*
Negative	19	7.0 ± 8.1	3 (15.8)
Radiological extension in PA graph of index case			
Moderate	111	11.1 ± 8.1	42 (37.8)
Severe	42	13.5 ± 6.7	21 (50.0)
Presence of cavity in PA graph of index case			
Absent	53	9.5 ± 7.2	16 (30.2)
Present	100	13.0 ± 7.9#	47 (47.0)#

*p<0.05, compare to AFB negative cases
#p<0.05, compare to cavity absent cases

In multiple regression analysis, in household contacts presence of cavity in index case was a risk factor for tuberculosis disease [odds ratio (OR) = 3.0, 95% confidence intervals (CI) = 1.2-4.2] and in household contacts younger than 15 years old smear positive index case was a risk factor for tuberculosis infection (OR = 3.8, CI = 1.0-13.7).

DISCUSSION

When compared the mean age in contacts determined active disease was lower than the index cases in this study. For this reason, we thought that most of index cases (65%) were constituted parents of home. In addition, in our study the number of male patients was higher in the index cases, but the number of female patients was higher in contacts determined active disease. In our opinion, the reason of this findings were that female contacts considered their health important, the majority of them have a lot of time because of not working.

In this study the frequency of TB in household contacts of pulmonary TB cases was found as 5.6%. It was detected that presence of cavity in the chest radiograph of index case increased the frequency of TB in household contacts. In our country, Kolsuz et al. found the frequency of TB in close contact of TB cases 2.6% [5] between January 1996 and December 2000, and 3.6% [6] between January 2001 and January 2003 in Eskisehir Deliklitas Tuberculosis Dispensary. In Hong Kong, Noertjojo et al. detected a rate of 1.7% TB patients in household contacts. They reported that tuberculosis patients were more common among in children ≤ 5 years of age and in those > 60 years of age. In addition, they detected more tuberculosis patients in contacts of index cases whose sputum smear and culture were positive [7]. Chee et al. detected a rate of 0.9% TB patients in investigation of 5699 close contacts of 1374 index case in Singapore [8]. In their study which they detected TB in 36 children younger than 5 years old, Shah et al. reported that household close interaction and delayed diagnosis in adult TB were the primary reasons of TB transmission to children in Arizona, U.S.A [9]. Marks et al. detected a rate of 2% active TB in investigation of 6225 close contacts of 1080 pulmonary TB patients in U.S.A [10]. In Diel et al.'s study, of the 421 close contact persons investigated, 40.1% had positive TST and 1.9% had active TB in Hamburg, Germany [11]. In our study frequency of TB disease was higher than these studies. Most of the regions in dispensary area were of lower socio-economic people. The mean number of persons in families of contacts was 4.92. The higher rate of tuberculosis patients among household contacts may be due to the bad aeration in houses and to the crowdedness of families. In our study, a high rate of active disease was detected in household contacts of index cases who had cavity than those did not have cavity. These results indicate that, being highly contagious, patients with cavity may cause more contacts to be infected and become ill.

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In this study, the frequency of TCT positivity in household contacts under 15 years old with index cases was found as 41.2%. The TB infection risk was higher in the household contacts under 15 years old of cases who were smear positive and had cavity. Rathi et al. [12] investigated prevalence and risk factors associated with tuberculin skin test positivity among household contacts of smear-positive pulmonary tuberculosis cases in Umerkot, Pakistan, and found that advanced contact' age, sleeping site relative to the index case, the intensity of the index case's AFB sputum-smear positivity and the contact's BCG scar presence were independent predictors of TST positivity among household contacts of AFB sputum smear-positive index cases. In India, Singh et al. found 33.8% of tuberculin test to be positive among children in household contacts with adults having pulmonary tuberculosis [13]. They found that important risk factors for transmission of infection were younger age, serious malnutrition, and absence of BCG immunization, contact with an adult who was sputum smear-positive, and exposure to environmental tobacco smoke [13]. In our study, BCG vaccination was applied to most of the contacts under 15 years old with index cases, and we found no relation between BCG scar's presence, age group and TST positivity. Our findings were similar with the survey from India for TST positivity household contacts with smear-positive pulmonary tuberculosis patients.

Gerald et al. detected higher rate of TST positivity in close contacts who were female, non-white, had crowded families and low income in Alabama, U.S.A [14]. Lutong et al. evaluated the contacts of newly diagnosed smear-positive pulmonary TB patients and TST positivity in the healthy control group. They found that 42% of very close contacts had positive TST, compared to 34% close contacts and 13% sporadic contacts and 16% of a healthy control group in Jinan, China [15]. Zangger et al. investigated totally 53 contacts of 15 years old African origin girl with pulmonary TB living in Switzerland [16]. They divided the contact persons into 3 groups. The first group consisted of close family and friends, the second of classmates and teachers and the third of more distant contacts. They found that 88% were infected in the first group 42% in the second group and 18% were infected in the third group. Besides they treated 1 of 9 cases in the first group because of active disease [16]. In former two studies it is seen that the risk of infection increases in close contact with closer contact to the index case and more contact period. In our study we evaluated tuberculosis risk only in household contacts of the index cases younger than 15 years old. In our study we found that mean TST reaction of household contacts under 15 years old was significantly higher in cases with index case having cavity and smear positive sputum than cases whose index case had no cavity and smear negative sputum. We attributed our result to the index cases with radiological cavity and smear positive sputum are more contagious and they infect household contacts in a higher rate.

There were some limitations of this study. As the study was done retrospectively, co morbidities (such as HIV) of the index case, and addictions of the close contacts like smoking and alcohol could not be evaluated.

In conclusion, household contacts of pulmonary TB cases are the most risky group for TB contamination and are the easiest group to detect TB cases. Index cases with cavity and positive sputum smear constitute great risk for TB infection and disease in household contacts. Close follow up of household contacts of such patients for tuberculosis is essential and important for tuberculosis control.

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