

Risk of Tuberculosis Among Household Contacts in Salvador, Bahia

Antonio Carlos Lemos^{1,2}, Eliana D Matos²,
Diana B Pedral-Sampaio¹ and Eduardo M. Netto¹

Prof. Edgard Santos University Hospital, Federal University of Bahia¹; Octávio Mangabeira Hospital, Secretary of the State of Bahia², Salvador/BA, Brazil

Tuberculosis is one of the most important infectious diseases in the world. Only 68% of the estimated new tuberculosis (TB) cases in Brazil are diagnosed. Our aim was to determine the risk of infection among household contacts. Study design. Cohort of tuberculin-negative household contacts followed for 12 Months. Methods. Household contacts of randomly selected index acid-fast bacilli (AFB)-positive TB cases were evaluated through clinical examination, thorax X-ray, tuberculin, AFB smear and culture. Contacts with a negative response to the tuberculin test (less than 10 mm diameter) were retested after 90 days. Tuberculin reversal (used as a parameter of infection risk) was defined as an increase of at least 10 mm from the last measurement. Results. 269 household contacts were followed. The prevalence of disease in this population was 3.7%. The prevalence of infection after the 12-month follow-up period was 63.9%. The risk of infection was 31.1% within 120 ± 48 days. Conclusion. Household contacts of AFB positive tuberculosis patients have a very high prevalence and risk of tuberculosis infection. TB preventive or therapeutic measures directed towards this group should be implemented in Brazil.

Key Words: Tuberculosis, infection, epidemiology, prevalence.

Tuberculosis is presently one of the main causes of morbi-mortality in the developing world. It is estimated that 8.3 million new tuberculosis (TB) cases occurred in 2000, including 3.5 million sputum acid-fast bacilli (AFB) positive diagnoses and 1.8 million deaths. One third of the world population is already infected [1]. In 1993, the World Health Organization (WHO) declared the tuberculosis problem as a "global emergency" [2]. Along with this crisis is the problem of the *M. tuberculosis* being resistant to several drugs. The purported causes for the permanence and even the increase of TB in the world are: (a) migration of populations from highly prevalent areas; (b) the HIV epidemic; (c) impoverishment of several populations, mainly in the underdeveloped world; and finally (d)

Received on 16 July 2004; revised 13 December 2004.

Address for correspondence: Dr. Eduardo M Netto, MD, MPH Hospital Universitário Prof. Edgard Santos/Universidade Federal da Bahia. Rua João das Botas, S/N 6o andar, Sala 1124 - Canela. Zip code: 40110-160 - Salvador - Bahia - Brazil.

The Brazilian Journal of Infectious Diseases 2004;8(6):424-430
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increased transmission in closed environments (including hospitals, prisons, host houses and poorly ventilated houses hosting index cases) [3-5].

In Brazil, the prevalence of infection due to tuberculosis in the overall population is quite high; it is presumed to be over 50%. It is estimated that only 68% of the new cases of patients with symptomatic TB are officially notified [1]. The investigation of household contacts is a recommendation of the National Program for the Control of Tuberculosis [6]. However, this investigation has not been a priority of Brazilian public services. In 1997, only 10.1% of the estimated contacts were investigated [7]. With the objective of reexamining the role of household contacts, we investigated the risk of transmission in the area of Salvador, the coastal capital city of Bahia, with 2.5 million inhabitants, having an HIV-prevalence rate of 133 cases/100,000 inhabitants [8].

Material and Methods

From March/1997 to April/1999, 69 patients, diagnosed by AFB positive sputum smear or by culture

for *Mycobacterium tuberculosis*, were randomly selected to participate in the cohort. They were selected from the outpatient clinic of the state reference hospital for tuberculosis treatment in Bahia - Octavio Mangabeira Hospital. The inclusion criteria were: (a) being the first TB case in the household (called "index case"); (b) being HIV-negative; (c) living in Salvador; and (d) never having been treated for TB. To improve treatment adherence, free food stamps were offered.

The contact was followed for at least 12 months. The visits were set to be every four months, when a clinical examination was made, an X-ray was taken and a tuberculin skin test (TST) was done to evaluate the infection rate. The TST was done on all contacts at the first meeting. The patient with an initial negative skin test performed a second test (in the contra lateral forearm) after at least 90 days following the first test, and repeated it again during the third visit if it was still negative. A TST was considered positive when an induration equal to or greater than 10 mm diameter was detected. A patient was considered newly reactive when there was an increase in the reaction of at least 10 mm compared to the previous reaction measurement. Since children in Brazil are routinely vaccinated against tuberculosis with BCG within 30 days after birth, the patients were divided into vaccinated (presence of a scar in the outface of the right arm) or not.

If there were any respiratory symptoms, a sputum smear was taken and cultured. All sputum samples were cultivated in Lowenstein-Jaensen media. The individual was classified as "TB case" if he (she) had a positive AFB smear or TB culture and/or a clinical picture of TB, a suggestive thorax X-ray plus clinical improvement with TB treatment within 30 days. All patients weighing 45 Kg or more were treated with Isoniazid (400 mg/day) plus Rifampim (600 mg/day) for six months, plus Pyrazinamide (2g/day) for the initial two months. Patients weighing less than 45 Kg had their dosages adjusted based on their weight, according to the Brazilian Ministry of Health guidelines for TB treatment.

Results

Of the selected 69 index cases treated, 68 patients completed the TB treatment and were diagnosed as cured. One abandoned the treatment after two months of therapy. Among the 69 index cases, 282 household contacts were found; 269 (95.4%) contacts completed the follow-up. The mean follow-up time was 346 ± 154 days (median: 314 days). Table 1 describes the demographic characteristics of the index cases and their contacts. Contacts with the BCG vaccination scar were younger than those without a scar (17.1 ± 10.0 versus 38.0 ± 17.8 years-old; $p < 0.0001$). An increased disease or infection risk was not found among the contacts when they were stratified according to the amount (months) of exposure time to the infectious index case (less than 1 month, between 1 and 3 months and more than that) ($p > 0.05$).

Table 2 describes the prevalence and incidence among the cohort of contacts; seven cases were found with TB disease at the first evaluation and three more during the follow-up (Figure 1). Infection was much more prevalent and 136 out of 269 contacts were found to be infected. During the follow-up, 36 more contacts were infected, with a cumulative prevalence of 63.9%. The risk of TB disease among the contacts was 1.1% and the risk of infection was 31.1%. There were no differences in the prevalence, the risk of infection or the development of disease among the contacts who were vaccinated or not.

The mean time between the first and second evaluation was 120 ± 48 days (median: 130 days). Thirty-six (31.1%) contacts converted during follow-up of the 117 negative TST contacts followed. During this time, 33 contacts converted into positive; this represented 91.7% (33/36) of those who would convert into positive at any time. Only three more contacts converted the skin test between the second and third evaluation. After the third evaluation, there were no more skin test conversions.

Discussion

Ten cases of active tuberculosis disease were found during the follow-up of one year of the 282 contacts of

Table 1. Demographic characteristics of the tuberculosis index cases and their household contacts

	Index cases	Contacts
Age (mean SD) in years	29 ± 11.9	25.9 ± 17.2
Age (median/range) in years	24	21
Age	14 to 66	1 to 72
Male (n / %)	48 / 69.6	135 / 50.2
Ethnicity (n / %)		
White	12 / 17.3	46 / 17.1
Mulatto	49 / 71.0	188 / 69.9
Black	8 / 11.6	35 / 13.0
BCG scar present		157 / 58.4
Age (mean ± SD) in years		
With visible BCG scar		17.1 ± 10.0*
Without visible BCG scar		38.0 ± 17.8

* - 17.1 X 38.0 - p < 0.0001.

Table 2. Point* and cumulative** prevalence and incidence of tuberculosis among the 269 contacts of 69 index tuberculosis cases

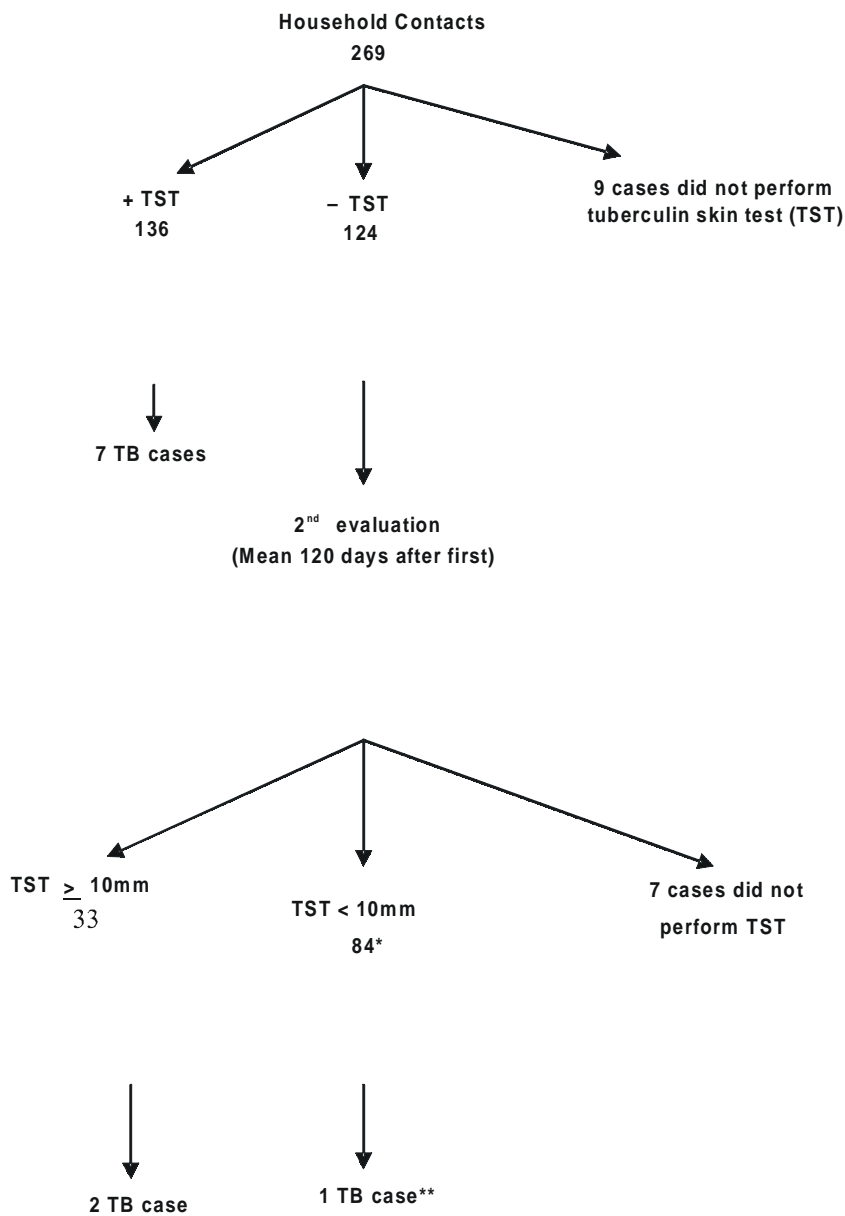
	Contact (n%)
Point prevalence	
Disease	7 (2.6)
Infection***	136 (52.3)
Cumulative prevalence	
Disease	10 (3.7)
Infection	172 (63.9)
Risk of disease ⁺	3 (1.1)
Risk of infection ⁺⁺	36 (31.1)

* At the first evaluation. ** During the whole period of evaluation. *** 9 contacts did not perform the tuberculin skin test in the initial evaluation. ⁺7 contacts were lost during follow-up. ⁺⁺Among the 116 negative skin test/individuals.

69 AFB-positive index cases. This represents a cumulative prevalence of 3.7% or 3,745 cases per 100,000 habitants, which is 50 times the annual incidence rate in Brazil of 75/100,000. This finding is similar to that reported by Picon et al. [9] (3.3%), similar to that found by Lapa et al. [10] (4.2%), greater than the 0.96% found by Carvalho et al. [11], and less than that found by Menzies et al. [12] 11%, Lemos and Matos [13] in

a similar population (8.4%) and Vidal et al. [14] (7.6%). Sundaram and Driver, in a review of a series of 21 studies from 1940-66, found a prevalence of 3.1 to 24.2% [15]. These rate variations could be due to methodology differences; in our previous report that demonstrated a prevalence of 8.4%, higher than that found in this study, the patients were invited to participate in the evaluation in a non-sequential and non-random way and there was

Figure 1. Follow-up diagram of the cohort of household contacts



* 3 cases increased TST reactivity more than 10 mm in the 3rd and 4th evaluations, but no new TB case was detected.

** Negative TST (9 to 18 mm).

no incentive for adherence [13]. Much lower adherence to the follow-up was reported by Askew (87% in children, 13% in adults) [16], Garcia Ordonez (26.9%) [17], Picon (57.0%) [9] and Drobniowski (85.0%) [18]. This may have led to a selection of those index cases that had symptomatic individuals at home. In our study, only 4.6% of the contacts did not adhere to the proposed follow-up as we supported them with specialized social and psychological care besides offering food stamps to the most needy ones. The micro epidemics in Menzies's report [12] increased the prevalence of TB. Contact definition differences, such as the nuclear family, which is more prevalent in economically advanced countries versus enlarged families that are prevalent in Africa and Brazil can affect the results; in our cohort only 25.3% of the contacts were not related to the index cases. The inclusion of other than AFB-positive index cases significantly diminished the transmission in some studies [9,12,14]. BCG vaccination among the contacts could also have an effect. Studies on TB vaccination are still controversial; they have demonstrated from no [19] to high protection [20], or protection against only severe forms of TB [21], mostly in infants [22]. We found no additional protection in vaccinated individuals, similar to other reports [11,15,23,24].

Longer exposure may increase the prevalence among contacts, as detected by studies with multidrug-resistant TB cases, whose natural course is infectious for longer periods [25 - 27]. On the other hand, the infectiousness diminishes greatly after the beginning of treatment [28-30]. Similar prevalence rates were found by Picon, Lapa & Silva and Carvalho [9,10,11]. We found no correlation between time (in months) of exposure and increased disease risk.

A cut-off of 10 mm to consider a PPD positive test was used for the diagnosis of prevalence and risk of infection, and an additional 10 millimeters over the initial test result was considered a positive test for the second and following ones. These values are greater than those used in other places where BCG vaccination is not given and the prevalence of non-tuberculosis mycobacterium is low [31,32], different from Brazil [33,34]. This strategy decreased the detection of false TB infections.

We found a point-prevalence infection of 52.3% and a cumulative prevalence of 63.9%. These findings are 2.1 and 2.5 times the estimated prevalence in the Brazilian population [1], but are similar to other authors' findings [11,13,15,23,34]. However our prevalence rates were significantly lower than those of contacts of multidrug-resistant patients ($p=0.0001$) (87%) [25]. Regarding infectiousness, only AFB-positive patients are important among contacts [27]. The index AFB positive patient has a greater importance for contact sickness, however, if the index patient is AFB negative, but culture positive, the infection rate is similar to that provoked by AFB positive patients.

The incidence of infectious TB can be calculated from the Annual Risk of Infection (ARI). An increase of 1 point percentage in the ARI has been associated with an increase of 49 smear-positive cases per 100,000 population [1]. The risk of infection during the 346 days of follow-up was 31.1%; using this rule-of-thumb, we project 1524 cases/100,000 population. The ARI was similar to that found by Carvalho (26.3%) [18]. The estimated ARI for Brazil is 0.8% [34], so our calculated ARI among the contacts was significantly higher.

Given similar risks of infection, younger contacts have less chance of being infected by *M. tuberculosis*; however this is the age at which most of the contacts were vaccinated in Brazil. We found a mean age of vaccinated subjects of only 17.1 years, versus 38 years for non-vaccinated individuals ($p = 0.0005$). On the other hand, we found that the chance of being recently infected (risk of infection), in this contact cohort, was the same and independent of age.

Conclusions

The contacts evaluated in this study were subjected to a high risk for developing active tuberculosis. The prevalence of infection was 2.5 times higher than for the general population, and the ARI was almost 40 times than that estimated for Brazil. This warrants a much better contact tracing and treatment program than what is currently implemented.

Acknowledgements

This paper was supported by NUPEP - "Núcleo de Pesquisa em Pneumologia" Tuberculosis Reference Center - State of Bahia Department of Health.

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