Positive tuberculin test and risk of infection by *Mycobacterium tuberculosis* in a tuberculosis clinic settled in an upright building, in Minas Gerais, Brazil

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ABSTRACT

Background: Occupational Tuberculosis (TB) can lead to work absenteeism and a negative professional impact. Knowing the reactivity of the tuberculin test and the risk of *M. tuberculosis* infection among healthcare professionals is essential for the revision and reinforcement of control measures against TB transmission. **Aim:** To assess the reactivity of tuberculin test and risk of *M. tuberculosis* infection among healthcare professionals working in an upright building, in which a TB Reference Clinic is placed. **Subjects and Methods:** A tuberculosis Skin Test (TST) was done to 251 staff members of a TB clinic that did not have a previous history or suspicion of TB and that did not have a previous TST done. Among subjects with absence of reaction, repeated tests were carried out to assess booster reaction. **Results:** Fifty one percent of studied subjects (129) had a positive tuberculin test. The booster phenomenon was evidenced in 35.7% (68/190). The seroconversion among non-reactive subjects, subjected to a new TST after one year, was 5.1%. The infection risk was 1.4. **Conclusions:** This study indicates an important occupational risk of infection in healthcare settings exposed to high TB incidence, and should be used to better allocate resources for infection control.

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Key words: Infectious disease transmission, patient-to-professional; Latent tuberculosis; Tuberculin test.

Reactividad a tuberculina en trabajadores de la salud de un centro de referencia de tuberculosis

Antecedentes: La tuberculosis ocupacional causa ausentismo laboral. Conocer la reactividad tuberculínica de los trabajadores de la salud ayuda a mejorar las medidas de control para evitar la infección laboral con *M. tuberculosis*. **Objetivo:** Estudiar la reactividad tuberculínica de un grupo de trabajadores de la salud de un centro de referencia de tuberculosis que está ubicado en una edificación vertical. **Material y Métodos:** Se realizó una prueba de tuberculina a 251 empleados de una clínica de tuberculosis, que no tenían antecedentes o sospecha de tuberculosis y quienes no habían sido sometidos previamente a la prueba. Aquellos sujetos que no respondieron a tuberculina fueron sometidos a una nueva prueba para evaluar la reacción de

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refuerzo. **Resultados:** El 51% de los sujetos estudiados tuvieron una reacción tuberculínica positiva. El fenómeno de refuerzo se observó en 69 de 190 sujetos (35,7%). La tasa de seroconversión en aquellos sujetos con una tuberculina negativa en que se repitió la prueba la cabo de un año, fue de 5,1%. **Conclusiones:** En este grupo de trabajadores de la salud expuestos a M. tuberculosis, hay una alta tasa de reactividad negativa a tuberculina.

Tuberculosis (TB) is a Public Health problem considered as occupational infectious disease, always as occurring in healthcare professionals. TB presents serious consequences when associated to multidrug resistant (MDR) strains' dissemination¹. The occupational TB could lead to work absenteeism and a negative professional impact. The knowledge about the occurrence of positive tuberculin test between healthcare professionals is one of the essential steps for revision and reinforcement of control measures against TB transmission. Different infection control measures, usually of simultaneous administrative and engineering character, have been implemented in industrialized countries, resulting in reduced nosocomial tuberculosis transmission. However, the effective role of individual infection control measures is difficult to establish. The implementation of such measures could be neither feasible, nor cost-effective, for resource-limited nations²⁻⁶.

In countries with high TB burden, the occupational risk has often been neglected and hidden by the high general population prevalence. Several studies indicate a higher TB risk between healthcare professionals, depending mainly on their time of service, professional category, and occasional utilization of respiratory protection. Other related factors are also mentioned, such as the delay in diagnosis for positive bacteriology patients, as well as the infrastructure precariousness and the barely structured work process, culminating in long shifts with doubled workday, stress and work overcharge²⁻⁴.

Seventy three thousand cases of tuberculosis were notified in Brazil in 2009, corresponding to an incidence coefficient of 50/100,000 inhabitants. This situation places Brazil within the list of 22 countries concentrating 80% of all tuberculosis cases around the world, occupying the 19th place in such list, according to data from the World Health Organization and the Brazilian Ministry of Health^{7,8}. Tuberculosis is the 4th death cause between infectious diseases, and the 1st one in HIV

positive patients. In total numbers, tuberculosis causes the death of about 4,500 victims per year.

In the State of Minas Gerais, an average of 6,085 cases/year occurred in the last six years, with an incidence coefficient of 23 cases/100,000 inhabitants; which represents the 4th lower incidence coefficient in the Brazilian Southeastern region, and the 4th higher TB burden in the country. The tuberculosis mortality coefficient was of 3.0/100,000 inhabitants, the percentage of cure between the new cases was of 70.2% and the proportion of treatment abandonment was of 8.5%, which could contribute for the increase of resistant tuberculosis cases⁹.

In Belo Horizonte, 1,897 new tuberculosis cases were notified in 2009 (incidence coefficient of 28.88/100,000 inhabitants), with cure rates of 66.2%, treatment abandonment rate of 19.7%, and tuberculosis mortality coefficient of 4.3%, data from the 2009 year.¹⁰ In recent studies developed in the Hospital of Clinics of the Federal University of Minas Gerais (HC/FUMG), a high occurrence of resistant TB (15.3%) was detected, which is similar to data reported in other series analyzing the resistance profile between hospital attended patients¹¹.

There are no recent studies evaluating M. tuberculosis infection in professionals who often circulate in TB reference clinics settled in upright buildings and attending patients with varied complexity grades.

The purpose of this study was to evaluate the positive tuberculin test and risk of infection in healthcare professionals, who work into upright buildings where a TB reference clinic is located.

Patients and Methods

This is a transversal, prospective, and descriptive study, developed between March 2006 and March 2008, in the Bias Forte Clinic (BFC) of the FUMG, located on the fifth floor of a seven floors

building. The employee regularly, uses the same elevators as the clinic patients.

This study was approved by the Institutional Review Board/Independent Ethics Committee of the Federal University of Minas Gerais.

The BFC has 308 employees. Only BFC staff members accepting to develop TST, signing an Informed Consent Form (ICF), and having neither previous TB history/suspicion, nor a previously executed TST were included in this study. The sample size calculation was determined based on a multicentric study developed in Brazil, describing the prevalence of positive TST (63%) in hospitals¹¹. An error of 5% and a confidence interval of 95% were admitted.

The risk analysis of TB infection was calculated using the model proposed by Ruffino-Neto $r = \frac{1}{t} \ln \frac{N_0}{N}$; where: r = infection risk, N_0 = number of infection-free individuals at baseline, N = number who remained infection-free after time t , t = time elapsed between the two Purified Protein Derivative (PPD) tests¹³.

The healthcare professionals were evaluated according to their respective functional categories (administrative staff, nursing professionals, physicians, psychologists, social assistants, and pharmacists, among others). A questionnaire structured and validated by REDE in TB-research/Brazil was utilized. Symptoms of active TB, *Bacillus Calmette-Guerin* (BCG) vaccination history, professional contact with TB or contact occurring outside working environment, and use of NIOSH-95 or PFF2 masks (respiratory protection standardized by the Ministry of Health, Brazil)⁸ were assessed during the work. The submission to any respiratory symptomatic screening, occurring at building entrance and during the study period, was also verified.

Purified Protein Derivative (PPD-RT 23 Mtb- 2 UT-Copenhagen-Denmark) was administered, in the amount of 0.1 mL, by the Mantoux technique (intradermal). Induration reading was developed with a ruler after 72 to 96 hours, considering its longer transverse axis, and the result was expressed in millimeters.⁸

Clinic staff members with negative first test (TST1), < 10 mm, were submitted to a new TT (Tuberculin Test) between one and three weeks after the first test (TST2), for evaluation of booster phenomenon. After 12 months, a third test (TST3) was developed in clinic staff members with

a persisting negative TT¹⁴, and an increase >10 mm in the induration, from TST2 to TST3, was considered as tuberculin conversion¹⁵.

The treatment for LTBI (Latent Tuberculosis Infection) was indicated for BFC healthcare professionals with positive TST and a contact history shorter than two years, or tuberculin conversion without signs of active TB. The medication utilized was isoniazide 10 mg/kg/day, maximal dose of 300 mg/day, for 6 months⁸.

Results

The number of BFC healthcare professionals included in this study was 251, out of a 308 total; a fraction corresponding to 82%. The average age was 40 years (17 to 69). The female gender represented 69% (175/251) and the male, 31% (77/251). The female gender presented positive TST in 96/175 (55%) and negative TST in 79/175 (45%). For the male gender, the TST was positive in 33/77 (43%) and negative in 44/77 (57%). Comparing the groups, 12% more women than men exhibited positive TST.

The BFC functional categories were: cleaning workers 101/251 (55.9%), administrative technicians 75/251 (29%), nurses 19/251 (7.5%), radiology technicians 7/251 (2.8%), physiotherapists 3/251 (1.2%), occupational therapists 3/251 (1.2%), social assistants 1/251 (0.4%), pharmacists 1/251 (0.4%), physicians 2/251 (0.8%), and psychologists 2/251 (0.8%).

Positive tuberculin test was verified in 51% (129/251) of included BFC staff members. One hundred and one out of these 251 (40%) exhibited BCG vaccination scar, and 150/251 (60%) had no scar. Out of the scarred individuals, 46/101 (45.5%) had positive TST, while 83/150 (55.5%) of the unscarred individuals had positive TST (Table 1). The booster phenomenon was evidenced in 35.7% (68/190) of the BFC staff members execu-

Table 1. Prevalence of *M. tuberculosis* infection in individuals with and without BCG vaccination scar

	With BCG scar (%)	Without BCG scar (%)	Total (%)
Workers	101	150	251
TST positive	46 (45.5)	83 (55.5)	129 (60)

ting the second TST. Only 32% of the healthcare professionals executed the third TST (39/122). The conversion rate between those developing TST was of 5.1% (2/39). The infection risk was of 1.4.

History of TB contact was reported in 125/251 (49.8%) healthcare professionals. One hundred and fifteen out of these 125 (92%) had had nosocomial contact, and 10/125 (8%) domiciliary contact.

All the employees with positive TST, exhibiting booster phenomenon and tuberculin conversion had not symptoms of active TB, and their thoracic X-ray did not evidence lesions suggestive of pulmonary sequel or signs of active disease.

The selection of symptomatic respiratory (SR) individuals was developed only when the patient effectively arrived to attendance floor (TB Clinic), but this selection did not occur when the patient entered the building. The healthcare professionals had started to use respiratory protection masks in the TB Clinic floor, only on occasion of its creation, in the 2001 year.

Two employees, 0.6% (2/308), had TB before the study and were excluded from it.

Discussion

This is the first work describing the LTBI in healthcare professionals working in a TB clinic settled in an upright building, as in Brazil, the majority of clinics attending TB patients are settled in horizontal and better ventilated buildings. The BFC offers a care program for patients of primary, secondary, and tertiary complexity; besides a reference clinic for TB. The BFC healthcare professionals are commonly exposed, because they circulate by elevators and corridors, close to TB and other diseases suspected population. A work developed in the United States of America (Washington State) draws the attention to the high risk of tuberculin reactivity in professionals working in the non nosocomial health area. The higher risk was verified in clinics and medical consulting rooms' professionals; with an infection rate of 4.7/10,000 professionals in this area, but the respective building characteristics of their workplaces were not described^{16,17}.

In this study, the average age was of 40 years and the predominant population was of female gender (69%), with a proportion of positive TSTs larger between women (55%) than between men

(43%), in the same way as described by other authors^{5,18}.

The positive tuberculin test at BFC was high (51%); a fact already described for hospitals, but never described for clinics placed in upright buildings. Therefore, control measures for these settings, similar to those adopted by hospitals, should be considered. For instance: measures of administrative and/or engineering character, measures for individual protection, and creation of a TB Control Commission to act effectively. In unvaccinated individuals, the prevalence was high (55.3%), demonstrating a high *M. tuberculosis* infection probably due to exposition, in the same way as occurring in hospitals (closed places), as the majority of BFC healthcare professionals had not a history of TB contact outside their work environment.

Even the TST-positive and BCG scarred individuals were, probably, infected in their workplace. Studies have demonstrated that individuals vaccinated during their childhood, and tested at an interval of 5 years or more, usually have a tuberculin reactivity pattern similar to that of their own reference population^{19,20}. In other words, BCG vaccination in childhood does not interfere with PPD results in adulthood. Besides, the contact history rate at BFC was of 92%, so it probably derives from exposition within the building. Recent studies have demonstrated the utility of Interferon Gamma Release Assay (IGRA) test for evaluation of latent *M. tuberculosis* infection; however, in the United States of America, authors have reported to be more cost effective to use IGRA test only in close contact, HIV seropositive individuals, and immigrants from countries with high TB prevalence²¹⁻²³. In this work, we have not utilized IGRA test, as it was not validated yet for utilization in the Brazilian population⁸.

The high tuberculin conversion (5.1%) and an infection risk of 1.4, three times higher than that found in the Brazilian general population, which is of 0.5, demonstrate both a high risk of recent transmission. Works just developed within Brazilian hospitals have reported a high conversion rate, but with significant decrease when measures of nosocomial control are implemented^{24,25,11}. It is convenient to emphasize that this just seroconverted population has higher risk to fall ill and so perpetuate TB transmission, increasing then the burden on the health system.

The healthcare professionals with tuberculin conversion were medicated with H 300 mg/day for 6 months, without any report of adverse reaction.

Prevention measures should be introduced in clinics with the same magnitude as BFC, in the same way as already occurring in hospitals, as these clinics do not present the typical Health Center structure corresponding to horizontal and better ventilated buildings. The use of mask and SR screening are practical and low cost measures; they should be adopted routinely by all nosocomial clinics within Brazilian hospitals, developing tuberculosis treatment within upright buildings. Such measures could decrease TB transmission in sceneries where the public health system cannot offer adequate buildings.

The limitations observed in this study were the small number of healthcare professionals that repeated the third TST, and the ignorance about the HIV status, which could influence the results.

Conclusion

This study indicates an important occupational risk of infection in health care settings with high TB incidence, and should be used to better allocate the limited resources for infection control. Moreover, it is necessary an architecture reevaluation for buildings in which TB patients are attended, in order to better avoid this disease transmission.

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