

# Original Article

## Epidemiological profile of tuberculosis cases reported among health care workers at the University Hospital in Vitoria, Brazil\*

Perfil epidemiológico dos casos notificados de tuberculose entre os profissionais de saúde no Hospital Universitário em Vitória (ES) Brasil

Thiago Nascimento do Prado<sup>1</sup>, Heleticia Scabelo Galavote<sup>2</sup>, Ana Paula Brioshi<sup>3</sup>,  
Thamy Lacerda<sup>3</sup>, Geisa Fregona<sup>4</sup>, Valdério do Valle Detoni<sup>5</sup>,  
Rita de Cássia Duarte Lima<sup>6</sup>, Reynaldo Dietze<sup>7</sup>, Ethel Leonor Noia Maciel<sup>8</sup>

### Abstract

**Objective:** To describe the epidemiological profile of tuberculosis cases reported among health care workers in the Tuberculosis Control Program of the Cassiano Antnio de Moraes University Hospital in Vitoria, Brazil. **Methods:** A retrospective descriptive study of secondary data was conducted between 2002 and 2006. **Results:** Twenty-five cases of health care workers with tuberculosis were reported: 8 in nursing technicians (32%); 4 in doctors (16%); 3 in nurses (12%); 2 in radiology technicians (8%) and 8 in professionals from other categories (32%). Of those 25 health care workers, 14 (56%) were male and 11 (44%) were female. The incidence of the disease was highest among those from 35 to 39 years of age. The predominant clinical presentation was extrapulmonary (12 cases, 48%), followed by pulmonary (11 cases, 44%) and a combination of the two (2 cases, 8%). Regarding comorbidities, AIDS, alcoholism and smoking, respectively, were present in 33.3% of the study population. Outcomes were as follows: 22 cases of cure (88%); 2 transfers (8%); and 1 death (4%). The proportion of health care workers diagnosed with tuberculosis in the period studied was 2.53%. **Conclusions:** The results show the need for health care workers who work in the tuberculosis control program to fill out the field 'professional occupation' on the tuberculosis case registry database reporting forms. In addition, this situation draws attention to the need to implement an occupational tuberculosis control program.

**Keywords:** Health profile; Tuberculosis/epidemiology; Health personnel; Prevalence.

### Resumo

**Objetivo:** Traçar o perfil epidemiológico dos casos notificados de tuberculose entre os profissionais de saúde no Programa de Controle da Tuberculose do Hospital Universitário Cassiano Antônio de Moraes, em Vitória (ES) Brasil. **Métodos:** Realizou-se um estudo descritivo e retrospectivo de dados secundários no período de 2002 a 2006. **Resultados:** Foram notificados 25 casos de profissionais de saúde com tuberculose: 8 técnicos de enfermagem (32%); 4 médicos (16%); 3 enfermeiros (12%); 2 técnicos em radiologia (8%) e 8 profissionais pertencentes a outras categorias (32%); 14 do sexo masculino (56%) e 11 do sexo feminino (44%). A faixa etária com maior incidência foi a de 35-39 anos. A forma clínica predominante foi a extrapulmonar com 12 casos (48%), seguido da pulmonar com 11 casos (44%), e 2 casos (8%) apresentaram ambas as manifestações. Entre os agravos associados, AIDS, etilismo e tabagismo apresentaram a mesma proporção entre a população do estudo: 33,3%. Quanto ao desfecho, houve 22 casos de cura (88%), 2 transferências (8%) e 1 óbito (4%). A proporção de profissionais de saúde com diagnóstico de tuberculose no período estudado foi de 2,53%. **Conclusões:** Os resultados deste estudo apontam a necessidade de os profissionais de saúde que trabalham nos programas de controle da tuberculose preencherem o campo "ocupação profissional" nas fichas de notificação do Sistema de Informação de Agravos de Notificação. Além disso, apontam para a necessidade de implementação de um programa de controle de tuberculose ocupacional.

**Descritores:** Perfil de saúde; Tuberculose/epidemiologia; Pessoal de saúde; Prevalência.

\* Study carried out at the *Universidade Federal do Espírito Santo* – UFES, Federal University of Espírito Santo – Vitória, Brazil.

1. Nurse. Epidemiology Laboratory of the *Núcleo de Doenças Infecciosas da Universidade Federal do Espírito Santo* – NDI/UFES, Infectious Diseases Center/Federal University of Espírito Santo – Vitória, Brazil.

2. Nurse. Collective Health Study Center of the *Universidade Federal do Espírito Santo* – UFES, Federal University of Espírito Santo – Vitória, Brazil.

3. Nursing Student. *Universidade Federal do Espírito Santo* – UFES, Federal University of Espírito Santo – Vitória, Brazil.

4. Nurse. Tuberculosis Control Program of the *Hospital Universitário Cassiano Antônio de Moraes* – HUCAM, Cassiano Antônio de Moraes University Hospital – Vitória, Brazil.

5. Coordinator of the Tuberculosis Control Program of the *Hospital Universitário Cassiano Antônio de Moraes* – HUCAM, Cassiano Antônio de Moraes University Hospital – Vitória, Brazil.

6. Professor in the Postgraduate Program in Collective Health of the *Universidade Federal do Espírito Santo* – UFES, Federal University of Espírito Santo – Vitória, Brazil.

7. Coordinator of the *Núcleo de Doenças Infecciosas da Universidade Federal do Espírito Santo* – NDI/UFES, Infectious Diseases Center/Federal University of Espírito Santo – Vitória, Brazil.

8. Professor of Epidemiology. Postgraduate Program in Infectious Diseases and Postgraduate Program in Collective Health of the *Universidade Federal do Espírito Santo* – UFES, Federal University of Espírito Santo – Vitória, Brazil.

Correspondence to: Ethel Leonor Noia Maciel. Centro de Ciências da Saúde, Núcleo de Doenças Infecciosas, Av. Marechal Campos, 1468, Maruípe, CEP 29040-090, Vitória, ES, Brasil.

Tel 55 27 2122-7210. E-mail: emaciel@ndi.ufes.br

Financial support: This study received financial support from *Rede Brasileira de Pesquisa em Tuberculose* – REDE TB, Brazilian Tuberculosis Research Network.

Submitted: 25 August 2007. Accepted, after review: 5 December 2007.

## Introduction

Prior to 1900, it was not accepted that health care workers involved in the treatment of patients with tuberculosis (TB) might be more susceptible to infection with *Mycobacterium tuberculosis* than is the general population. Some studies conducted between 1900 and 1920 demonstrated the safety of treating patients with TB in sanatoriums designated for that purpose.<sup>(1)</sup>

However, in 1929, a study involving 449 premedical students who were submitted to tuberculin skin tests (TSTs) revealed that 35.6% reacted positively at the beginning of the course, and that this proportion increased to 41% by the end of the third year and to 67.8% by the end of the final year. In fact, 50.2% of the nonreactors at the beginning of the course became reactors by the end of the course. More alarming numbers were seen among students graduating in 1933 and 1936, 57.7 and 77.9% of whom, respectively, became reactors during the course.<sup>(2)</sup>

Subsequent studies have demonstrated the importance of *M. tuberculosis* transmission in students and health care workers.<sup>(3-12)</sup> In addition, other studies showed significant increases in nosocomial transmission, especially between TB/HIV co-infected patients and health care workers, when biosafety guidelines were not strictly followed.<sup>(13,14)</sup>

In a study conducted in Vitória, Brazil, involving nursing students of the Federal University of Espírito Santo, a 10.5% TST conversion rate was observed, compared to the 0.5% expected rate in the state (Espírito Santo), confirming that nursing students are in fact more susceptible to infection with *M. tuberculosis* than is the general population.<sup>(11)</sup>

In another study, carried out at the Clementino Fraga Filho University Hospital of the Federal University of Rio de Janeiro, the TST conversion rate observed among health care workers was 9.2%, considerably greater than the 4% found in a Rio de Janeiro slum.<sup>(6)</sup> In a study conducted in the same hospital, involving medical students, the researchers observed that the prevalence of positive TSTs among these students increased as their practical activities progressed. In addition, the risk was greater during the years of clinical training, when the medical students more frequently had contact with patients. A similar result was obtained in a study involving medical students at the Ferreira Machado Hospital,

in Campos, Brazil.<sup>(7,10)</sup> Despite the significant differences in prevalence and incidence of the infection, when compared to those reported at the beginning of last century, the values obtained in these recent studies suggest that these professionals are at greater risk than is the general population.

Some studies conducted in developed countries have demonstrated that the risk of developing TB is lower among health care workers than in the general population. A 30-year retrospective study showed that, in Finland, the risk is lower among health care workers than in the general population. However, Finland has an excellent TB control program.<sup>(15)</sup>

In contrast, a study conducted in 1996 in Malawi, a sub-Saharan area in the African continent, revealed that the incidence of TB among health care workers in 40 hospitals that treat TB patients was twelve times greater than that of the general adult population  $\geq 15$  years of age.<sup>(16)</sup>

In a study carried out at a referral hospital for TB in Turkey over a 15-year observation period (1986-2000), 15 cases of health care workers diagnosed with TB were found among the 734 employees who worked in that hospital annually during the study period, translating to an average incidence of 199.9/100,000 health care workers. It is of note that the average incidence of TB in the general population of that country was 40.8/100,000 inhabitants in the period studied. These results show that the relative risk was approximately 5 times greater among health care workers than in the general population.<sup>(17)</sup>

**Table 1** – Demographic characteristics of health care workers with tuberculosis at the Cassiano Antônio de Moraes University Hospital.

| Characteristic      | n  | %  |
|---------------------|----|----|
| Gender              |    |    |
| Female              | 11 | 44 |
| Male                | 14 | 56 |
| Age bracket (years) |    |    |
| 20-29               | 8  | 32 |
| 30-39               | 11 | 44 |
| $\geq 40$           | 6  | 24 |
| Race                |    |    |
| Caucasian           | 15 | 60 |
| Black               | 10 | 40 |

Only one study of this nature was found in the literature related to Brazil. That study was conducted from 1975 to 1977 at the Institute for Medical Treatment of Civil Servants, in the city of São Paulo. The authors found that employees of the Institute developed TB four times more frequently than did the general population.<sup>(3)</sup> In addition, TB among health care workers is currently little discussed.

In view of these facts, the objective of this study was to describe the epidemiological profile of TB cases reported among health care workers in the *Programa de Controle da Tuberculose do Hospital Universitário Cassiano Antônio de Moraes* (PCT/HUCAM, Tuberculosis Control Program of the Cassiano Antonio de Moraes University Hospital) between 2002 and 2006.

## Methods

This was a retrospective descriptive study with analysis of secondary data. The locale studied was the HUCAM. The PCT/HUCAM is a statewide reference for TB treatment. The PCT operates on the premises of the HUCAM, which is also a referral center for the admission and diagnostic investigation of patients with TB in the state of Espírito Santo. During the study period, the average number of patients admitted annually was 123.

Data collection was first performed through the identification of cases of health care workers with TB reported during the 2002–2006 period. This identification was obtained through the analysis of reporting forms of the *Sistema de Informação de Agravos de Notificação* (SINAN, Tuberculosis Case Registry Database) provided for the study. Subsequently, using a research instrument, the information contained in SINAN reporting forms and patient charts was recorded. When laboratory data (results of sputum smear microscopy and culture for mycobacteria) were not present in the above-mentioned sources, they were obtained directly from the Mycobacteriology Laboratory of the Infectious Diseases Center.

All of the information obtained and contained in the research instrument were used in order to construct a database that was stored using Microsoft Excel software and later transferred to the STATA statistical program, version 9.0 (Stata Corp., College Station, TX, USA), for absolute and relative frequency calculations. For the calculation

of TB prevalence rates among health care workers, we used the number of professionals registered with the PCT/HUCAM during the study period divided by the number of cases reported in the same period.

The study was approved by the Ethics in Human Research Committee of the Health Sciences Center of the Federal University of Espírito Santo (Protocol no. 118/06).

## Results

During the study period, 25 cases of health care workers with TB were reported. Of those 25 health care workers, 14 (56%) were male and 11 (44%) were female. The incidence of the disease was highest among those from 30 to 39 years of age. There were 15 cases in Caucasians (60%) and 10 in Blacks (40%). Demographic data of health care workers included in the study are shown in Table 1.

Table 2 shows the distribution of cases by professional occupation. There were 8 nursing technicians (32%), 4 doctors (16%), 3 nurses (12%), 2 radiology technicians (8%) and 8 professionals from other categories (32%). The nursing staff (nurses, nursing technicians and nursing assistants) accounted for approximately 48% of the cases, and the medical staff (doctors and medical students) accounted for 20%.

Of the 25 health care workers with TB, 24 (96%) were classified as new cases and one (4%) was classified as reactivation of latent infection. Concerning the manifestation of the disease, the predomi-

**Table 2** - Distribution of health care workers with tuberculosis by professional occupation.

| Category               | n | %  |
|------------------------|---|----|
| Nursing technician     | 8 | 32 |
| Doctor                 | 4 | 16 |
| Nurse                  | 3 | 12 |
| Radiology technician   | 2 | 8  |
| Pharmacist             | 1 | 4  |
| Physical therapist     | 1 | 4  |
| Nutritionist           | 1 | 4  |
| Medical student        | 1 | 4  |
| Autopsy technician     | 1 | 4  |
| Maintenance technician | 1 | 4  |
| Nursing assistant      | 1 | 4  |
| Health agent           | 1 | 4  |

nant clinical presentation was extrapulmonary, with 12 cases (48%), followed by pulmonary, with 11 cases (44%), and both, with 2 cases (8%). As shown in Table 3, among all extrapulmonary forms, including the 2 cases with clinical manifestation associated with the pulmonary form, there were 8 cases of pleural involvement (57.1%), 3 cases of peripheral lymph node involvement (21.4%), 2 cases of ocular involvement (14.3%) and one case of bone involvement (7.2%).

In Table 4, we can see distribution of pulmonary TB cases by sputum smear microscopy and sputum culture test results. Sputum smear microscopy was performed in all 11 (100%) of the reported cases of pulmonary TB. Among those 11 cases, the sputum smear microscopy result was positive in 7 (63.6%) and negative in 4 (36.4%). Sputum culture was performed in 10 cases (90.9%). Among those 10 cases, sputum culture was positive in 9 (90%) and negative in only one (10%). When comparing sputum smear microscopy results with sputum culture results, we observed that 3 of the 4 individuals presenting negative sputum smear microscopy results were also submitted to sputum culture, and that 2 of those 3 cases (66.6%) were thus identified as positive.

Smear microscopy of some other material was performed in 8 (66.7%) of the 12 cases of extrapulmonary TB. Of those, 7 cases (87.5%) tested negative and only one case (12.5%) tested positive. There were only 4 cases (33.3%) in which some material other than sputum was cultured: 2 cases tested positive, and 2 cases tested negative (Table 5).

Chest X-rays were performed in 24 cases (96%). The results of those 24 chest X-rays were classified as consistent with suspicion of TB in 17 cases (70.8%) and as normal in 8 cases (29.2%). A TST was

performed in 19 cases (76%), of which 2 (10.5%) were nonreactors, one (5.3%) was a weak reactor, and 16 (84.2%) were strong reactors.

Serologic testing for HIV was performed in 21 cases (84%), of which 2 (9.5%) were positive, 18 (85.7%) were negative, and one (4.8%) was still in progress at this writing. As comorbidities, AIDS, alcoholism and smoking were present in equal proportions among the study population: 33.3% (2 cases of each). It is important to highlight that the information on this variable was not available for 19 (76%) of the 24 health care workers evaluated. Regarding the treatment regimen received, 24 health care workers (96%) were treated with regimen I, and only one case (4%) was treated with regimen IR. Outcomes were as follows: 22 cases of discharge after cure (88%); 2 transfers (8%); and 1 death (4%).

Between 2002 and 2006, 988 TB cases were reported to the PCT/HUCAM, and 25 health care workers with TB were identified. Therefore, the proportion of health care workers diagnosed with TB in the period studied was 2.53%.

## Discussion

The risk of infection with *M. tuberculosis* and of active TB in professionals varies, principally depending upon the prevalence of TB in the reference population, as well as differing among the various professional categories in the health care area.<sup>(18)</sup>

In our study, we observed that the prevalence of TB was greater among nursing technicians than among other professionals, perhaps because the

**Table 3** - Clinical presentation of tuberculosis among health care workers at the Cassiano Antônio de Moraes University Hospital.

| Clinical presentation      | n  | %    |
|----------------------------|----|------|
| Pulmonary                  | 11 | 44   |
| Extrapulmonary             | 12 | 48   |
| Pleural                    | 8  | 57.1 |
| Peripheral lymph node      | 3  | 21.4 |
| Ocular                     | 2  | 14.3 |
| Bone                       | 1  | 7.2  |
| Pulmonary + extrapulmonary | 2  | 8    |

**Table 4** - Distribution of health care workers diagnosed with pulmonary tuberculosis through sputum smear microscopy and sputum culture.

| Variable                | n  | %     |
|-------------------------|----|-------|
| Sputum smear microscopy |    |       |
| Not performed           | 0  | 0     |
| Performed               | 11 | 100.0 |
| Positive                | 7  | 63.6  |
| Negative                | 4  | 36.4  |
| Sputum culture          |    |       |
| Not performed           | 1  | 10.1  |
| Performed               | 10 | 90.9  |
| Positive                | 9  | 90.0  |
| Negative                | 1  | 10.0  |

**Table 5** - Distribution of health care workers diagnosed with extrapulmonary tuberculosis through smear microscopy and culture of material other than sputum.

| Variable                           | n | %    |
|------------------------------------|---|------|
| Smear microscopy of other material |   |      |
| Not performed                      | 4 | 33.3 |
| Performed                          | 8 | 66.7 |
| Positive                           | 1 | 12.5 |
| Negative                           | 7 | 87.5 |
| Culture of other material          |   |      |
| Not performed                      | 8 | 66.7 |
| Performed                          | 4 | 33.3 |
| Positive                           | 2 | 50   |
| Negative                           | 2 | 50   |

former, due to their function of providing treatment directly to patients, are in prolonged contact with TB patients. The previously cited study conducted in Turkey revealed a higher prevalence among the nursing staff.<sup>(17)</sup> We also found that, when the three nursing staff categories were combined, the prevalence in Brazil was higher among nurses than among health care professionals in other categories.

We know that the nursing staff is directly responsible for patient care, often in places where the quality of health care is poor due to a lack of proper working conditions. Professionals working at the HUCAM, as well as at other health care facilities that treat patients with TB, often comment that they not supplied with protective equipment, and that, when they are, there is not enough for all of those who require it. Another problem is the lack of information on the part of professionals regarding the need to use such protective equipment and the correct manner in which to use it.<sup>(19)</sup>

Members of the nursing staff, together with students, often perform procedures such as changing decubitus, changing bandages, applying suction and changing bed linens. Through mechanical activities, such techniques can contribute to the propagation of the bacillus, through Wells nuclei, to other sectors, whose employees are not directly involved in these activities.<sup>(19)</sup>

Some studies corroborate the supposition that the nursing staff and the medical staff are more susceptible to infection with *M. tuberculosis*, since they spend more time with the patient. In a cross-sectional study followed by a longitudinal study, both conducted in a general hospital in Rio de

Janeiro between February of 1994 and September of 1997, researchers applied a TST questionnaire aimed at assessing occupational risk of TB infection.

<sup>(8)</sup> Among the 1,250 health care workers who participated in the first phase of the study, 649 (52%) presented positive TSTs. In the longitudinal study, health care workers over 30 years of age presented lower risk of TST conversion, whereas being a doctor or a nurse represented significantly greater risk.

In another similar study, conducted from 1999 to 2000 and involving 4,419 health care professionals working in four hospitals in three states in Brazil, the rate of TST positivity was 63.1% and the TST conversion rate was 8.7% (10.7 per 1,000 person-months). The multivariate analysis showed that the following risk factors were associated with TST conversion (10-mm increase in relation to initial induration): suffering nosocomial exposure to patients with pulmonary TB; being a nurse; and working at a hospital where biosafety measures have not been implemented. In cases of recent BCG vaccination (past 2 years), a 15-mm increase in TST induration remained associated with conversion. We found that TST conversion rates were higher in hospitals that did not adopt any measures to protect against TB transmission (19.8% vs. 8.7%). Of the professionals analyzed, 1.5% reported having had contact with TB in the community during the study period, compared with 33% who reported having had contact with TB in the workplace.<sup>(9)</sup>

A study conducted in 15 hospitals in the four largest cities in Canada demonstrated that female health care workers are at greater risk for nosocomial TB infection than are their male counterparts. The authors attributed this finding to the fact that the nursing staff comprises mostly women.<sup>(20)</sup> In addition, the previously mentioned study carried out at the Institute for Medical Treatment of Civil Servants revealed a higher prevalence among females.<sup>(3)</sup> However, in our study, the prevalence was higher among males. The authors of a study conducted in New York City analyzed TB cases in health care workers during the 1998-2002 period and found that the highest proportion of cases was among those in the 35-54 year age bracket.<sup>(21)</sup> In our study, the highest proportion of cases was found among those in a lower age bracket.

The predominant clinical presentation of the disease in our study was extrapulmonary TB, identified through histopathological examination. This

finding is somewhat surprising, since it differs from the findings of other studies<sup>(3,19,20,22)</sup> and from what is seen in the general population of the city of Vitória.<sup>(23)</sup> This finding can be explained by the fact that the PCT/HUCAM is a reference for TB control. Therefore, some cases in which the TB diagnosis has not been confirmed are referred from other health care facilities to the PCT/HUCAM. In addition, the HUCAM is a referral center for patients with AIDS in the state.

Sputum culture has come to be widely used in the diagnosis of TB, since it presents a sensitivity of 80–93%.<sup>(24)</sup> Sputum culture is considered the gold standard in TB diagnosis and allows diagnostic confirmation of the disease in paucibacillary individuals. This method also allows tests to identify the etiologic agent, as well as drug sensitivity tests, to be performed.<sup>(25)</sup> In our study, all patients with pulmonary forms of TB were submitted to sputum smear microscopy, and most produced positive results. Sputum culture was also performed in most such patients, and the result was positive in the majority of the cultures.

Serologic testing for HIV is recommended in all cases diagnosed with TB.<sup>(26)</sup> In practice, however, this does not occur. A study conducted in Salvador, Brazil<sup>(27)</sup> corroborated this supposition, since serologic testing for HIV was performed in only 6.6% of the cases diagnosed with TB. In our study, however, serologic testing was performed in most individuals, demonstrating that the PCT/HUCAM follows the instructions issued by the Brazilian National Ministry of Health. Serologic testing for HIV was positive in 9.5% of the cases. A similar result was found among the health care workers evaluated in the previously cited study conducted in New York City.<sup>(21)</sup>

Identifying comorbidities is relevant, since a single concomitant disorder can alter the treatment outcome. It is necessary to identify these comorbidities in order to provide individualized treatment for each case, thereby reducing treatment noncompliance and increasing cure rates by optimizing treatment. We identified a high proportion of cases in which these data were not fully recorded. It should be noted that alcoholism and co-infection with HIV are major risk indicators of TB severity, and that alcoholism is also a major risk factor for noncompliance with treatment.<sup>(28,29)</sup>

Regarding treatment outcome, most patients were discharged after cure, a satisfactory result in

view of the goal set by the National Ministry of Health for the general population.<sup>(25)</sup> In addition, in a study conducted in 8 public hospitals in the city of Ethekwini, South Africa,<sup>(30)</sup> the cure rate among health care professionals was found to be only 22.2%. Only 40.7% completed the treatment, and 9% died from TB.

The previously mentioned study conducted in New York, which was carried out in the 1994–2002 period, showed the proportion of TB cases among health care workers to be approximately 2.9%.<sup>(21)</sup> During the 2002–2006 study period, a proportion of approximately 2.53% was found at the PCT/HUCAM. Regarding the proportion found in our study, we believe that the number of TB cases among health care workers might be much higher, since the field ‘professional occupation’ was left blank on many of the reporting forms.

We found no studies on development of the disease among health care workers in Brazil. Therefore, our data could only be compared to those of studies conducted in other countries, which constitutes a limitation of the present study, since TB prevalences in reference populations of other studies are usually different from those found in Brazil. However, our findings do not differ much from those of the other studies cited here.

The results of our study show the need for health care workers who work in TB control programs to fill out the field “professional occupation” on SINAN reporting forms. Completion of this information is extremely important for specific groups, such as health care workers, to be actually recognized as a population at risk for developing TB. In addition, our findings show the need for biosafety norms agreed upon by the TB control program to be incorporated into routine practice at health care facilities. Finally, for all of this to become effective, health care professionals should recognize the fact that they themselves are susceptible to developing TB and, on that basis, demand appropriate workplaces and working conditions for the activities they pursue.

## References

1. Sepkowitz KA, Schluger NW. Tuberculosis and the health care worker. In Davis AL, editor. Tuberculosis. New York: Brownand Company; 1996. p. 935–43.
2. Diehl HS, Boynton RE, Geist-Black S, Myers JA. Prevention of tuberculosis among students of medicine. JAMA. 1948;138:8–11.

3. Jafferian PA, Morrone LC, Santos MAS. Frequência da tuberculose entre funcionários de uma instituição de assistência médica e os resultados parciais de um programa de controle. *Rev Bras Saúde Ocup.* 1977;5(1):30-3.
4. Lombardi C, Jafferian PA, Santos MA, Morrone LC. Controle de Tuberculose entre funcionários de um Hospital Geral. *Rev. Médica do IAMSPE.* 1977;8:13-9.
5. Klitzman S, Kellner P. Control of tuberculosis in the workplace: toward an integration of occupational health and public health. *Occup Med.* 1994;9(4):723-34.
6. Souza GR, Gonçalves ML, Carvalho AC, Oliveira JR, Issa L, Kritski A. Controle de Infecção Hospitalar por Tuberculose. *Pulmão RJ.* 1997;6(4):220-7.
7. Silva VM, Oliveira JR, Santos FM, Araújo CM, Kritski AL. Prevalência de infecção pelo *Mycobacterium tuberculosis* entre alunos da Faculdade de Medicina da Universidade Federal do Rio de Janeiro. *J. Pneumol.* 2001;27(2):77-82.
8. Muzzy de Souza GR, Carvalho AC, Cravo R, Furukawa F, DeRiemer K, Conde MB, et al. Viragem da prova tuberculínica entre profissionais de saúde em atividades num hospital universitário, referência para AIDS, no Rio de Janeiro, Brasil. *Pulmão RJ.* 2002;11:64-75.
9. Silva VM, Cunha AJ, Kritski AL. Tuberculin skin test conversion among medical students at teaching hospital in Rio de Janeiro, Brazil. *Hosp Infect Control Epidemiol* 2002;23:591-4.
10. Soares LC, Mello FC, Kritski AL. Prevalência de prova tuberculínica entre alunos da Faculdade de Medicina de Campos (RJ). *J Bras Pneumol.* 2004;30(4):440-7.
11. Maciel EL, Viana MC, Zeitoune RC, Ferreira I, Fregona G, Dietze R. Prevalence and incidence of *Mycobacterium tuberculosis* infection in nursing students in Vitória, Espírito Santo. *Rev Soc Bras Med Trop.* 2005;38(6):469-72.
12. Maciel EL, Meireles W, Silva AP, Fiorotti K, Dietze R. Nosocomial *Mycobacterium tuberculosis* transmission among healthcare students in a high incidence region, in Vitória, State of Espírito Santo. *Rev Soc Bras Med Trop.* 2007;40(4):397-9.
13. Sokolove PE, Mackey D, Wiles J, Lewis RJ. Exposure of emergency department personnel to tuberculosis: PPD testing during an epidemic in the community. *Ann Emerg Med.* 1994;24(3):418-21.
14. Zaza S, Blumberg HM, Beck-Sagué C, Haas WH, Woodley CL, Pineda M, et al. Nosocomial transmission of *Mycobacterium tuberculosis*: role of health care workers in outbreak propagation. *J Infect Dis.* 1995;172(6):1542-9.
15. Raitio M, Tala E. Tuberculosis among health care workers during three recent decades. *Eur Respir J.* 2000;15(2):304-7.
16. Harries AD, Nyirenda TE, Banerjee A, Boeree MJ, Salaniponi FM. Tuberculosis in health care workers in Malawi. *Trans R Soc Trop Med Hyg.* 1999;93(1):32-5.
17. Hosoglu S, Tanrikulu AC, Dagli C, Akalin S. Tuberculosis among health care workers in a short working period. *Am J Infect Control.* 2005;33(1):23-6.
18. Franco C, Zanetta DM. Tuberculose em profissionais de saúde: medidas institucionais de prevenção e controle. *Arq. cienc. Saude.* 2004;11(4):244-252.
19. Maciel EL. Infecção por *Mycobacterium tuberculosis* em estudantes de enfermagem: um estudo de incidência através do Teste PPD [dissertation]. Rio de Janeiro: Universidade Federal do Rio de Janeiro; 1999.
20. Menzies D, Fanning A, Yuan L, Fitzgerald M. Tuberculosis among health care workers. *N Engl J Med.* 1995;332(2):92-8.
21. Driver CR, Stricof RL, Granville K, Munsiff SS, Savranskaya G, Kearns C, et al. Tuberculosis in health care workers during declining tuberculosis incidence in New York State. *Am J Infect Control.* 2005;33(9):519-26.
22. Jiamjarasrangi W, Hirunsuthikul N, Kamolratanakul P. Tuberculosis among health care workers at King Chulalongkorn Memorial Hospital, 1988-2002. *Int J Tuberc Lung Dis.* 2005;9(11):1253-8.
23. Prado TN, Vieira R, Maciel ELN. Perfil Epidemiológico dos novos casos de tuberculose no Município de Vitória-ES. In: *Anais do XLIII Congresso da Sociedade Brasileira de Medicina Tropical*; 2007. p. 243-3.
24. Brodie D, Schluger NW. The diagnosis of tuberculosis. *Clin Chest Med.* 2005;26(2):247-71, vi.
25. Susemihl MA, Ferrazolli L, Ueki SY, Gimenez RD, Palaci M. Avaliação do método de Ogawa-Kudoh para o cultivo de micobactérias. *Rev Bras Patol Clin.* 1993;29:51-4.
26. Ministério da Saúde. Secretaria de Políticas de Saúde. Departamento de Atenção Básica. Manual Técnico de Controle da TB; cadernos de atenção básica. 6th ed. Brasília: Ministério da Saúde; 2002.
27. Xavier MI, Barreto ML. Tuberculose na Cidade de Salvador, Bahia, Brasil: o perfil na década de 1990. *Cad Saude Publica, Rio de Janeiro.* 2007;23(2):445-53.
28. Barroso EC, Morais MFM, Campelo CL, Barroso JB, Rodrigues JLN. Fatores associados aos tratamentos inadequados em grupo de portadores de tuberculose multirresistente. *J. Pneumol.* 2003;29(6):350-7.
29. Ferreira AA, Queiroz KC, Torres KP, Ferreira MA, Accioly H, Alves MS. Os fatores associados à tuberculose pulmonar e a baciloscopia: uma contribuição ao diagnóstico nos serviços de saúde pública. *Rev bras epidemiol.* 2005;8(2):142-9.
30. Naidoo S, Jinabhai CC. TB in health care workers in KwaZulu-Natal, South Africa. *Int J Tuberc Lung Dis.* 2006;10(6):676-82.