Epidemiological monitoring of tuberculosis in a general teaching hospital*

Monitoramento epidemiológico da tuberculose em um hospital geral universitário

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Abstract

Objective: To describe the epidemiological monitoring of exposure to tuberculosis in a hospital environment and to analyze the profile of the disease in a general teaching hospital. **Methods:** A descriptive and retrospective study of tuberculosis cases diagnosed between 2000 and 2006, with the determination of indicators of morbidity and mortality, which were compared with the general population of patients treated at the hospital and with the hospital employees who developed active tuberculosis. **Results:** There were 763 patients who were treated for active tuberculosis (mean, 109 patients/year), 481 (63.1%) of whom were male. Most of the patients were in the 30-59 year age bracket. Tuberculosis that was exclusively pulmonary or extrapulmonary predominated. However, among the hospitalized patients, the combination of pulmonary and extrapulmonary tuberculosis, as well as exclusively noninfectious tuberculosis, predominated. Comorbidities were more prevalent among the hospitalized patients and among those who evolved to death. Only 52.8% of the cases treated at the hospital were reported. The overall hospital indicators showed longer length of hospital stay and greater mortality among the patients with tuberculosis. The incidence and prevalence show that there was a high risk of exposure to tuberculosis in the hospital during the period studied. **Conclusions:** The proposed indicators can potentially help standardize epidemiological monitoring procedures for nosocomial tuberculosis, and the epidemiological profile described in this study can contribute to a better understanding of the situation of tuberculosis in Brazil.

Keywords: Tuberculosis/epidemiology; Cross infection/prevention & control; Epidemiologic surveillance/statistics & numerical data; Risk management.

Resumo

Objetivo: Descrever o monitoramento epidemiológico da exposição à tuberculose realizado em ambiente hospitalar e analisar o perfil da doença em um hospital geral universitário. **Métodos:** Estudo descritivo e retrospectivo dos casos diagnosticados de tuberculose no período entre 2000 e 2006, com a determinação de indicadores de morbidade e mortalidade, que foram comparados a população geral de pacientes atendidos no hospital e com o total de funcionários do hospital que desenvolveram tuberculose ativa. **Resultados:** Foram atendidos 763 pacientes com tuberculose ativa (média, 109 pacientes/ano), sendo 481 (63,1%) do sexo masculino. A faixa etária mais atingida foi a de 30 a 59 anos. As formas clínicas pulmonares e extrapulmonares exclusivas foram predominantes. Entretanto, entre os pacientes internados, as formas pulmonares associadas às extrapulmonares e as formas pulmonares não baciliferas exclusivas foram mais frequentes. A presença de comorbidades foi mais prevalente entre os pacientes internados e entre os que evoluíram para óbito. Apenas 52,8% dos casos atendidos no hospital foram notificados. Os indicadores hospitalares gerais demonstraram maior tempo de internação hospitalar e mortalidade entre os pacientes com tuberculose. **Conclusões:** A incidência e prevalência indicam um alto risco de exposição à tuberculose no hospital no período estudado. Os indicadores propostos apresentam um potencial de padronização dos procedimentos de monitoramento da tuberculose hospitalar, e o perfil epidemiológico aqui descrito poderá contribuir para um melhor entendimento da situação da doença no país.

Descritores: Tuberculose/epidemiologia; Infecção hospitalar/prevenção & controle; Vigilância epidemiológica/estatística & dados numéricos; Controle de risco.

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Introduction

In 1993, the World Health Organization declared tuberculosis a global public health emergency, stating that it is the leading cause of death from a curable infectious disease in adults.[1-3] Brazil ranks 15th in terms of the absolute number of cases of the disease among the 22 countries that, together, account for approximately 80% of all cases worldwide.[1,3,4] In 2005, the incidence of tuberculosis in the state of Rio de Janeiro, Brazil, was 73.4 cases per 100,000 population, and the statewide mortality was 5.0 cases per 100,000 population, making that state the worst in the country in terms of the impact of tuberculosis.[2]

Underdiagnosis, treatment abandonment and increased risk factors for the development of tuberculosis, especially the AIDS epidemic, cancer and other immunosuppressive diseases, as well as the progressive aging of the population,[5-7] the emergence of bacterial resistance and the disorganization of the public health system, have increased the demand for facilities providing more advanced medical care, especially general and teaching hospitals.[2,8]

The risk of nosocomial transmission is recognized to be the result of the interrelationship among the characteristics of the hospital, the incidence of the disease in its reference population and the existence of effective in-hospital biosafety programs.[4,8-11] This risk can be particularly high when there is increased exposure combined with inadequate biosafety measures.[12-14]

The hospital under study has approximately 270 beds, has characteristics of a center for advanced medical care and is a regional referral center for procedures such as bronchoscopy and thoracic surgery, as well as for the treatment of AIDS and cancer.[15] It is located in the metropolitan area of the city of Niterói, serving cities with an incidence rate higher than 100 new cases of tuberculosis per 100,000 population. However, it is not a referral center for the admission of patients with this diagnosis.

The in-hospital epidemiological surveillance (ES) activities, including active surveillance for cases, are carried out in the emergency room and on the infectious and parasitic diseases (IPD) ward. However, spontaneous reporting remains low among the health care professionals who work in patient care. In 2006, the Nosocomial Tuberculosis Control Program was implemented in order to systematize and disseminate effective techniques for disease prevention and control in the hospital environment, expanding the ES activities and implementing the adoption of appropriate biosafety measures.

Therefore, the objective of the present study was to describe the epidemiological monitoring of exposure to tuberculosis within the context of in-hospital ES activities and to analyze the profile of the disease in a general teaching hospital as a tool to assess the risk of exposure to the disease in this environment.

Methods

This was a retrospective longitudinal study of a cohort of patients who were treated in the emergency room, outpatient clinics and wards of a general teaching hospital between 2000 and 2006. The reference population that comprised the denominator of the indicators of in-hospital morbidity was the general population of patients admitted in the same period. The database of patients with tuberculosis treated at the hospital was built based on direct collection of data produced by the various departments of the hospital. We also determined the number of hospital employees diagnosed with active tuberculosis during the study period.

One criterion for inclusion in the study was the existence of a record of the patient treatment in one or more of the following data sources: (a) Epidemiological Surveillance Unit registry database (tuberculosis report forms); (b) microbiology laboratory database (positive results on direct examination or culture); (c) database records of patients admitted to the IPD ward (receiving a primary or secondary diagnosis of tuberculosis at discharge); and (d) histology laboratory database records (positive results for or results suggestive of tuberculosis on examination of any biological specimen identified and analyzed). We excluded patients with positive test results from the microbiology laboratory, or with positive or suggestive test results from the histology laboratory, and for whom no other information allowing the identification of the clinical form of the disease was available.

The variables included in the study were grouped into three categories: sociodemographic variables; clinical and laboratory variables; and

treatment-related variables (year of treatment and reporting).

The formulas described in Chart 1 were used to determine the in-hospital tuberculosis indicators (incidence, prevalence, risk index, mortality and readmission rate).

The results are presented in contingency tables in which the variables are distributed by hospital sector (absolute and relative frequency) and by clinical form (descriptive statistics).

The indicators related to hospitalization (mean length of hospital stay, readmission rate, mortality and underreporting, as well as the proportion of inpatients with tuberculosis/HIV co-infection or concomitant tuberculosis/diabetes) were determined for each study year and for the period as a whole.

The incidence density and the prevalence were determined considering the total number of patients hospitalized for tuberculosis (any clinical form) and considering exclusively the subgroup of patients with infectious pulmonary tuberculosis.

For the risk index, we considered the time elapsed (in days) from admission to the 15th day of treatment in patients diagnosed with infectious pulmonary tuberculosis, bearing in mind that, after the initiation of specific treatment, the risk of disease transmission seems to diminish progressively over the first 15 days of treatment in new cases.[2,8,9]

The indicators were estimated by year, study period and hospital sector at admission and were grouped as follows: IPD ward; adult medical wards; adult emergency room; adult surgical wards; and pediatric sectors (medical ward, surgical ward and emergency room).

Relative risks and odds ratios, together with the respective 95% CIs, were estimated to quantify the risk of exposure to infectious pulmonary tuberculosis, and the incidence density or the risk index estimated for the total number of cases in the period, respectively, were used as the bases of comparison.

The number of cases of active tuberculosis among the hospital employees was obtained from the tuberculosis control program and the department of occupational health of the hospital under study.

To process the data and determine the indicators, we used the Data Wizard tool of the freeware BrOffice Calc, version 2.4, and the statistical freeware R, version 2.7.1 (R Development Core Team, 2008).

The study design was approved by the research ethics committees of the institutions involved (registration nos.: CAAE 0064.0.031.03-08 and CAAE 90026.0.258.258-08).

Results

Between 2000 and 2006, there were 763 patients who were treated for tuberculosis, in a total of 793 hospital visits (30 cases of readmission). Of those 763 patients, 334 (43.8%) were treated as inpatients, 344 (45.1%) were treated as outpatients and 85 (11.1%) were treated in the emergency room only. The mean number of patients treated/year was 109 ± 22.4. The mean number of hospital visits/year was 113 ± 21.9 visits. We excluded 2 patients with test results that were positive for or suggestive of tuberculosis but for whom no clinical

Chart 1 - Indicators used and respective formulas.

Indicator	Formula
Incidence	$\frac{\text{Number of first admissions for tuberculosis} \times 1{,}000}{\text{Total number of patient-days}}$
Prevalence	$\frac{\text{Number of patients hospitalized for tuberculosis} \times 1{,}000}{\text{Total number of patients hospitalized}}$
Risk index	$\frac{\text{Length of hospital stay (in days, up to the 15th day of specific treatment)} \times 1{,}000}{\text{Total number of patient-days}}$
Mortality	$\frac{\text{Number of deaths among the patients hospitalized for tuberculosis} \times 100}{\text{Number of patients hospitalized for tuberculosis}}$
Readmission rate	$\frac{\text{Number of readmissions for tuberculosis} \times 100}{\text{Number of patients hospitalized for tuberculosis}}$

information allowing the identification of the clinical form of the disease was available.

In the frequency distribution by gender, we found 63.1% males and 36.9% females, translating to a male/female ratio of 1.7:1.0 in the periodThe proportion of patients in the 30-59 year age bracket was over 56% for all hospital sectors and for all clinical forms of tuberculosis.

The variables "level of education", "skin color" and "profession" were not evaluated due to the high proportion of patient charts lacking these data (75%, 66% and 53%, respectively).

Pulmonary tuberculosis predominated in all sectors, followed by the pleural and lymph node forms. The distribution of cases of extrapulmonary tuberculosis among the inpatients was as follows: lymph node tuberculosis (in 14.6%)

Table 1 - Distribution of patient characteristics, by hospital sector, during the 2000-2006 period.

Characteristic	Hospital sector							
	Outpatient clinic		Emergency room		Inpatient wards		Total	
	n	%	n	%	n	%	n	%
Gender								
Male	220	64.1	55	64.7	206	61.7	481	63.1
Female	123	35.9	30	35.3	128	38.3	281	36.9
Subtotal	343	100.0	85	100.0	334	100.0	762	100.0
Age bracket								
< 15 years	6	2.4	1	5.6	24	7.2	31	5.2
15 to 29 years	59	23.8	3	16.7	71	21.3	133	22.2
30 to 44 years	78	31.5	9	50.0	112	33.5	199	33.2
45 to 59 years	66	26.6	3	16.7	86	25.7	155	25.8
60 to 69 years	25	10.1	0	0.0	20	6.0	45	7.5
≥ 70 years	14	5.6	2	11.1	21	6.3	37	6.2
Subtotal	248	100.0	18	100.0	334	100.0	600	100.0
Short clinical form								
Infectious pulmonary	201	58.4	52	61.2	121	36.2	374	49.0
Infectious pulmonary and extrapulmonary	4	1.2	1	1.2	27	8.1	32	4.2
Noninfectious pulmonary	6	1.7	2	2.4	45	13.5	53	6.9
Noninfectious pulmonary and extrapulmonary	0	0.0	0	0.0	15	4.5	15	2.0
Extrapulmonary	133	38.7	30	35.3	126	37.7	289	37.9
Subtotal	344	100.0	85	100.0	334	100.0	763	100.0
Presence of comorbidity								
Reported	37	10.8	3	3.5	221	66.2	261	34,2
Not reported	307	89.2	82	96.5	113	33.8	502	65.8
Subtotal	344	100.0	85	100.0	334	100.0	763	100.0
Started treatment								
Yes	27	8.1	4	25.0	254	76.0	285	41.6
No	305	91.9	16	75.0	80	24.0	401	58.4
Subtotal	332	100.0	20	100.0	334	100.0	686	100.0
Reason for discharge or exclusion								
Transfer to outpatient clinic	109	31.7	14	16.5	256	76.6	380	49.8
Death	1	0.3	0	0.0	54	16.2	55	7.2
Loss to follow-up	234	68.0	71	83.5	24	7.2	328	43.0
Subtotal	344	100.0	85	100.0	334	100.0	763	100.0
Reporting								
Yes	133	38.7	19	22.4	251	75.2	403	52.8
No	211	61.3	66	77.7	83	24.8	360	47.2
Subtotal	344	100.0	85	100.0	334	100.0	763	100.0

and pleural tuberculosis (in 8.9%). It is also of note that, the analysis of the distribution of the clinical forms by hospital sector reveals that, among the inpatients, the combination of infectious pulmonary tuberculosis and extrapulmonary tuberculosis predominated, as did the combination of noninfectious pulmonary tuberculosis and extrapulmonary tuberculosis as well as exclusively noninfectious pulmonary tuberculosis (84.4%, 100% and 84.9%, respectively).

The presence of comorbidities, such as HIV infection, diabetes, alcoholism, mental illness or others (cancer, lupus or sarcoidosis), was reported in 10.8% of the outpatient cases, in 3.5% of the emergency room cases and in 66.2% of the inpatient cases. The analysis of this presence by clinical form reveals that, among all cases of infectious pulmonary tuberculosis or extrapulmonary tuberculosis diagnosed at the hospital, comorbidities were found in 27.0% and 29.8%, respectively. In contrast, among the cases of noninfectious pulmonary tuberculosis, comorbidities were present in 77.4% and, among the cases of combination of infectious or noninfectious pulmonary tuberculosis and extrapulmonary tuberculosis, comorbidities were found in 65.6% and 80.0%, respectively.

Treatment was initiated at the hospital in 41.9% of all cases diagnosed at the hospital and in 76.0% of the inpatient cases.

As for type of admission, we observed that, among the inpatients, the diagnosis was made for the first time in 69.2% of the cases. In 12.0%, the diagnosis was made after recurrence or treatment dropout, and, in 4.5% of the cases, the patients had been under treatment at other health care facilities up until the time of hospital admission.

Reporting occurred in 38.7% of the outpatient cases, in 22.4% of the emergency room cases and in 75.2% of the inpatient cases, totaling 52.8% of all cases treated at the hospital.

In the evaluation of the reasons for discharge, we observed that, in 68.0% of the outpatient cases and in 83.5% of the emergency room cases, there were no hospital records of referral for treatment at another facility, which would be essential, since tuberculosis is not treated at the hospital under study. Therefore, those cases can be characterized as having been lost to follow-up. Of the patients lost to follow-up, 49.8% presented with infectious pulmonary tuberculosis and 48% presented with exclusively extrapulmonary tuberculosis.

Among the inpatients, 76.6% were discharged to the outpatient clinic, 16.2% died and 7.2% were lost to follow-up (Table 1).

Regarding the in-hospital indicators in the study period, the mean length of hospital stay among the patients diagnosed with tuberculosis was 25.0 ± 4.5 days, compared with 10.4 ± 2.3 days for the total number of patients admitted to the hospital.

The rate of hospital readmission among the patients diagnosed with tuberculosis ranged from 4.2% to 15.9%, in 2005 and 2006, respectively, and was 9.0% for the 2000-2006 period as a whole.

Mortality among the patients hospitalized for tuberculosis was 16.1% in the study period. For the total number of patients admitted to the

Table 2 - Distribution of the in-hospital indicators, by year, during the 2000-2006 period.[a]

Indicator	Year							
	2000	2001	2002	2003	2004	2005	2006	2000-2006
Overall mean length of hospital stay[b]	12.1	14.9	10.5	9.8	8.0	9.2	8.6	N/A
TB-related mean length of hospital stay	18.8	27.1	18.1	27.5	23.0	28.1	28.5	25.0
TB-related readmission rate	4.3	8.3	15.2	6.8	13.3	4.2	15.9	9.0
Overall in-hospital mortality[b]	6.2	5.4	5.6	5.0	4.7	4.6	4.6	N/A
TB-related mortality	19.2	8.3	15.2	8.5	24.4	21.1	13.6	16.1
Overall underreporting	38.2	58.6	68.5	55.5	55.0	29.8	40.4	47.2
Inpatient-related underreporting	18.4	41.1	52.6	30.2	27.4	18.9	37.3	24.8
Overall comorbidity of TB and HIV infection	14.7	13.5	17.4	18.2	20.2	20.6	19.1	17.9
Inpatient-related comorbidity of TB and HIV infection	28.6	33.3	34.1	33.3	39.2	36.5	33.3	34.2
Inpatient-related comorbidity of TB and diabetes	2.0	5.1	2.6	1.6	3.9	4.0	3.9	3.3

TB: tuberculosis. [a]Values expressed as %. [b]Source: medical file.

hospital, mortality ranged from 4.6% (in 2000) to 6.2% (in the 2005-2006 period).

During the study period, tuberculosis/HIV co-infection was reported in 17.9% of the hospital visits (all sectors). The separate analysis of the inpatient cases alone revealed a rate of 34.2% for the study period. Concomitant tuberculosis and diabetes was reported in 3.3% of the inpatient cases in the period (Table 2).

The evaluation of the indicators (incidence, prevalence and risk index) in terms of admission of patients with tuberculosis in the various study years revealed great variability in their annual distribution.

As for the various hospital sectors at admission, the risk of exposure varied according to the indicator observed. However, it remained above the overall risk in the IPD ward, followed

Table 3 - Distribution of in-hospital indicators of tuberculosis (incidence,[a] prevalence[b] and risk index[c]), by year and hospital sector at admission,[d] with their respective relative risks and rate ratios, as well as of the number of hospital employees with active tuberculosis, by year, during the 2000-2006 period.

Variable	Incidence	Incidence (IP)	RR[e] (95% CI)	Prevalence	Prevalence (IP)	Risk index	RaR[e] (95% CI)	Hospital employees with active TB n
Year								
2000	0.81	0.45	1.42 (0.93-2.15)	6.48	3.44	6.89	1.34 (1.20-1.48)	4
2001	0.58	0.18	0.56 (0.31-1.04)	7.94	2.24	2.66	0.52 (0.44-0.61)	4
2002	0.53	0.14	0.45 (0.23-0.89)	6.30	1.66	1.86	0.36 (0.30-0.44)	3
2003	0.80	0.42	1.33 (0.90-1.96)	8.36	4.25	8.11	1.58 (1.44-1.73)	2
2004	0.74	0.38	1.19 (0.77-1.84)	6.45	3.16	5.33	1.04 (0.92-1.16)	4
2005	0.93	0.38	1.20 (0.81-1.79)	7.90	3.20	6.03	1.17 (1.06-1.30)	5
2006	0.58	0.26	0.81 (0.50-1.30)	5.01	2.21	4.63	0.90 (0.80-1.01)	5
Site								
IPD ward	8.08	3.92	12.32 (9.42-16.12)	106.29	50.86	52.58	10.21 (9.50-10.99)	-
Adult medical wards	0.75	0.36	1.14 (0.82-1.60)	12.05	5.77	6.69	1.30 (1.20-1.40)	-
Adult emergency room	0.52	0.27	0.86 (0.45-1.63)	4.04	2.12	5.83	1.13 (0.98-1.30)	-
Pediatric wards	0.28	0.13	0.40 (0.17-0.99)	2.23	0.93	4.28	0.83 (0.71-0.98)	-
Adult surgical wards	0.22	0.03	0.09 (0.04-0.21)	2.40	0.28	0.43	0.08 (0.07-0.10)	-
Other sectors	0.00	0.00	-	0.00	0.00	0.00	-	-
Total	0.72	0.32	1.00	6.83	2.93	5.15	1.00	-

IP: infectious pulmonary tuberculosis; RR: relative risk; RaR: rate ratio; TB: tuberculosis; IPD: infectious and parasitic diseases. [a]All forms and in patients with IP, per 1,000 patients/day. [b]All forms and in patients with IP, per 1,000 treated patients. [c]In patients with IP, per 1,000 patients/day. [d]In the study period as a whole. [e]RR and RaR are related to the total (95% CI).

by the adult medical wards, and was nearly zero in the adult surgical wards. The risk of exposure in the adult emergency room can be considered higher than the overall risk only in terms of the risk index indicator. During the study period, no cases were recorded in the obstetrics ward or in the neonatal ICU, which were classified as "other sectors".

As for the occurrence of active tuberculosis among the hospital employees, we found that there were 4 cases in 2000, 4 cases in 2001, 3 cases in 2002, 2 cases in 2003, 4 cases in 2004, 5 cases in 2005 and 5 cases in 2006 (Table 3).

Discussion

The higher risk of tuberculosis transmission among health care professionals, especially among those working in hospitals, in relation to the general population, has been well documented.[13] Since the average number of patients/year diagnosed with tuberculosis at the hospital under study exceeded 100, the study period can be considered to present "a high annual burden of active tuberculosis or a high burden of exposure of health care professionals, or both".[8,10]

As for the sociodemographic characteristics, there was a predominance of males, which is in accordance with the literature on tuberculosis, despite the fact that the male/female ratio ranged from 1.7 to 3.5.[16-21]

Most of the patients were in the 30-59 year age bracket, a finding that has been reported in most studies of patients hospitalized for tuberculosis.[16,18,22] This indicates that the population most affected is that of adults, especially males, in their economically productive years, which further increases the social costs of tuberculosis, particularly in poorer countries.

As for the distribution by clinical form, the Brazilian National Ministry of Health[2] estimates that, in the general population, pulmonary tuberculosis accounts for approximately 80% of cases and extrapulmonary tuberculosis accounts for approximately 20%. However, among inpatients, the ratio between pulmonary tuberculosis and extrapulmonary tuberculosis tends to be lower. In the present study, tuberculosis that was exclusively pulmonary was found in 49.7% of the inpatients, whereas extrapulmonary tuberculosis was found in 37.7%. Similar findings have been reported in studies conducted in Brazil or in countries with similar incidence rates, the proportion of cases of extrapulmonary tuberculosis among inpatients ranging from 33% to 45%.[16,17,19,20,22,23] In our study, the most common forms of extrapulmonary tuberculosis among the inpatients were the lymph node and pleural forms, as has also been reported in other studies.[17,24]

It is of note that tuberculosis treatment was initiated at the facility under study in only 41.9% of all diagnosed cases (inpatients and outpatients), compared with 76.0% of the inpatient cases. This might be due to the recommendation by the department of pulmonology that specific treatment be initiated only in hospitalized patients for whom discharge is not possible.

The predominance of new cases among inpatients has also been detected by other authors, underscoring the finding, relatively common in the literature, that the percentage of new cases of tuberculosis diagnosed at general hospitals in Brazil is high, especially in large metropolises such as Rio de Janeiro and São Paulo.[16,22,25]

In the present study, comorbidities were detected in 66.2% of the inpatients, a finding that has also been reported in various studies of patients admitted to general or teaching hospitals.[16,18,23,26]

Comorbidities are known to be risk factors for the occurrence of clinical forms that are more severe and more difficult to diagnose. The high percentages of comorbidities found among the cases of combined pulmonary and extrapulmonary tuberculosis diagnosed at the hospital seem to corroborate this point.

We found that only 52.8% of the cases treated at the hospital were reported. Other studies conducted in Brazil quantify this percentage based on the relationship between data available from the *Sistema de Informações sobre Mortalidade* (Mortality Database) and from the *Sistema Nacional de Agravos de Notificação* (National Case Registry Database), in studies of tuberculosis-related deaths, with percentages ranging form 23% and 58%.[25,27,28] This situation is more serious when analyzed together with the percentage of cases that were lost to follow-up in our study, there being need for a subsequent evaluation of the state case registry database in order to determine whether specific treatment

for such cases was initiated at other health care facilities.

For the study period, the mean length of hospital stay among the patients diagnosed with tuberculosis was 2.5-times longer than that found for the total number of patients treated at the hospital. However, other studies have found similar results (mean hospital stays ranging from 26 to 32 days) for patients with tuberculosis admitted to general hospitals.[16,17,22]

The 9% readmission rate among the patients diagnosed with tuberculosis during the study period was similar to the 10% reported in another study, involving patients hospitalized for tuberculosis in the city of São Paulo.[22]

The mortality rate among the patients hospitalized for tuberculosis in the present study is approximately 3-times higher than that found for the total number of patients treated at the hospital and is quite close to that reported in other studies.[16,19]

As for the in-hospital indicators, the Centers for Disease Control and Prevention[10] recommend that, before determining the most appropriate biosafety measures for use in each setting, the magnitude of risk in the various locales where health care professionals work be analyzed. The Brazilian National Ministry of Health[29] also recommends that, when the necessary information is available, epidemiological indicators be determined and evaluated in view the local circumstances of the health care system.

The results obtained for the in-hospital indicators (incidence, prevalence and risk index) in this study demonstrate great annual variability, which is as expected for rare events analyzed in short time series. To date, however, there have been no studies of their use as indicators of nosocomial exposure assessment. Nevertheless, studies of the occurrence of tuberculosis in hospital populations have identified prevalences ranging from 0.70% to 5.03%.[23,24] Furthermore, none of the studies cited here made reference to the occurrence of active tuberculosis among their health care professionals.

As for the hospital sectors at admission, the highest overall risk and the highest risk for cases of infectious pulmonary tuberculosis were found in the IPD ward, which was expected since most respiratory isolation beds are on that ward. However, significant risk was detected in the adult emergency room and adult medical wards, all of which are gateways for patients undergoing diagnostic investigation in various medical specialties and are devoid of any measures for appropriate environmental control.

Although small, the fluctuations in the rates of tuberculosis in each year of the series seem to be correlated with the number of new cases of tuberculosis detected among all hospital employees in the following year. It was not possible to survey the true workload of each professional in the years prior to disease onset, since the workload allocation is defined in each professional category or by each teaching department and circulation among the several sectors is quite common, preventing this sectorial analysis.

The use of secondary hospital data to build indicators is recognized to have limitations, the most important of which is probably that related to the fact that admissions are selective and have characteristics that are defined by the availability of beds in predetermined medical specialties in each institution. In addition, hospital records are not designed for research, neither in terms of the completeness of the data nor in terms of the diagnostic criteria used. Furthermore, defining the population at risk is not a trivial task.[30]

We hope that the present study will contribute to increasing the body of knowledge about tuberculosis in general hospitals. With the adoption of the epidemiological monitoring procedures described here, we believe that it is possible to make in-hospital ES activities more efficient. The widespread adoption of the indicators proposed in this study will allow the standardization of epidemiological monitoring procedures for nosocomial tuberculosis in Brazil, thereby helping to improve the quality of care provided to patients with tuberculosis and to reduce the occupational risk among health care professionals.

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