ORIGINAL ARTICLE

Pleural tuberculosis in the state of Roraima, Brazil, between 2005 and 2013: quality of diagnosis

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ABSTRACT

Objective: To evaluate the quality of diagnosis and the epidemiological profile of patients with pleural tuberculosis in the state of Roraima, Brazil, in order to provide technical support for the development and implementation of public policies to combat the disease. **Methods:** This was a cross-sectional study designed to determine the prevalence of pleural forms of tuberculosis in Roraima between 2005 and 2013 and to evaluate the diagnostic criteria used, as well as their determinants. This study was based on secondary data from the Brazilian Case Registry Database, including all reported cases of pleural tuberculosis in the state during the study period. Diagnoses based on bacteriological or histopathological confirmation were defined as high-quality diagnoses. **Results:** Among the 1,395 cases of tuberculosis reported during the study period, 116 (8.3%) were cases of pleural tuberculosis, accounting for 38.9% of all cases of extrapulmonary tuberculosis in the sample. The incidence rate of pleural tuberculosis did not follow the downward trend observed for the pulmonary form of the disease during the same period. The prevalence of cases with a high-quality diagnosis was 28.5% (95% CI: 20.4-37.6%). In a univariate analysis, none of the demographic or clinical characteristics collected from the database were found to have a significant impact on the outcome (as explanatory variables). **Conclusions:** The quality of the diagnoses in our study sample was considered unsatisfactory. Limited access to specific diagnostic methods might have contributed to these results.

Keywords: Tuberculosis/diagnosis; Tuberculosis/epidemiology; Tuberculosis, pleural.

INTRODUCTION

Tuberculosis is a major public health problem worldwide. It is estimated that two billion people, approximately one third of the world population, are infected with *Mycobacterium tuberculosis*. In 2012, 8.6 million people developed tuberculosis and 1.4 million died from the disease worldwide; in Brazil, 82,755 new cases were reported.[1] Despite specific public policy efforts, Brazil is one of the 22 countries that collectively account for 80% of all cases of tuberculosis worldwide.[2] In 2008, tuberculosis was the fourth leading cause of death from infectious diseases and the leading cause of death in AIDS patients in Brazil.[2]

Among the extrapulmonary forms of tuberculosis, pleural tuberculosis is the most common in HIV-seronegative adults.[3] The diagnosis of pleural tuberculosis is primarily based on the detection of *M. tuberculosis* by direct examination or culture of pleural fluid or a pleural tissue specimen, as well as on the specific histopathological finding of granulomas.[3-5] A combination of histological examination and culture of a pleural tissue specimen leads to diagnosis in up to 90% of cases.[3-7]

The state of Roraima, which has great environmental and sociocultural diversity, is located in northern Brazil, within the boundaries of the "Legal Amazon", and shares an extensive border with Guyana and Venezuela. Roraima is characterized by the size of its indigenous population, which (at approximately 15%) is proportionally larger than is that of any other state in Brazil.[8,9] These individuals are considered to be more vulnerable to developing tuberculosis, some studies showing that the incidence of the disease is up to ten times higher in indigenous peoples than that in the general population.[10]

Within the state of Roraima, the Brazilian National Tuberculosis Control Program has been fully implemented in all 15 cities and in the two Special Indigenous Health Districts. In 2013, 170 new cases of tuberculosis were reported in the state, among which there were 12 cases of pleural tuberculosis.[11] However, pleural tuberculosis represents an additional challenge, given that the assessment required for a reliable diagnosis of the pleural form of tuberculosis is available only at the single tertiary referral center in Roraima, which opened relatively recently.

Despite documented advances in the provision of diagnostic services in the state of Roraima, the system of referral and counter-referral among the primary, secondary, and tertiary levels of health care is rudimentary.[12] There have been no studies investigating the epidemiological profile of patients with pleural tuberculosis in the state.

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In addition, the quality of diagnosis among reported cases of pleural tuberculosis is unknown, as is the impact that the availability of a facility specializing in thoracic diseases has on that quality.

The objective of the present study was to evaluate the epidemiological profile of patients with, as well as the quality of diagnosis of, pleural tuberculosis in the state of Roraima. We also aimed to define the impact that the recent availability of sample collection techniques and methods used for specific diagnosis of tuberculosis within the public health care system in the state capital, Boa Vista, has had on the quality of diagnosis.

METHODS

Study design

This was a cross-sectional study designed to assess the prevalence of reported cases of pleural tuberculosis with a high-quality diagnosis in the state of Roraima, Brazil, between January of 2005 and December of 2013. The study was based on secondary data for the state, retrieved from the *Sistema de Informação de Agravos de Notificação* (SINAN, Brazilian Case Registry Database). For each reported case, the quality of diagnosis was assessed in accordance with the recommendations of the Brazilian National Ministry of Health National Tuberculosis Control Program, as described on its official reporting form.

A diagnosis of pleural tuberculosis was considered to be of high quality if the case reported met the following criteria: a positive smear microscopy or culture result in a pleural fluid sample or a positive culture result in a specimen of the parietal pleura; and histopathological positivity for AFB or histopathological results suggestive of tuberculosis, in a pleural specimen.[3] Individual, socioeconomic, and clinical patient data contained in the aforementioned instrument and potentially related to the diagnosis and progression of the disease were also analyzed.

In addition, data from the 2010 census[13] were used in order to estimate socioeconomic indicators and other risk factors that could be determinants of the dynamics of the diagnosis of the disease in question in the sample under consideration.

Sample and sampling

All cases of tuberculosis reported between 2005 and 2013 were analyzed consecutively and without selection. Of those, we included all cases of pleural tuberculosis (with or without pulmonary tuberculosis).[11] The sample was divided into two groups: cases reported between 2005 and 2009 (2005-2009 group); and cases reported between 2010 and 2013 (2010-2013 group). During the latter period, sample collection techniques and methods used for appropriate diagnosis of tuberculosis were available within the public health care system in the state of Roraima. The thoracic diseases department was accessible to patients in the latter group, as were diagnostic methods such as thoracentesis, percutaneous pleural biopsy, thoracoscopy, and video-assisted thoracoscopy. Such resources were not available within the referral network during the former period.

Data analysis

Categorical variables were expressed as absolute and relative frequencies, whereas quantitative variables were expressed as mean and standard deviation. The variable "outcome" represents the proportion of reported cases of pleural tuberculosis whose diagnosis was based on mycobacteriological or histopathological examination of specimens of pleural fluid or pleura (here referred to as high-quality diagnoses), with its corresponding 95% confidence interval (Newcombe-Wilson method).

The explanatory variables were extracted from individual data collected from the SINAN files, which include age, level of education, gender, place of residence, type of admission (recurrence or readmission), clinical data (form of disease, test results, and means of diagnosis), and comorbidities (AIDS, alcoholism, diabetes mellitus, and mental illness). Because of the assumption that all racial classifications are error-prone, racial classification was simplified into two categories in the present study: indigenous and non-indigenous.

For temporal analyses, we used the chi-square test for trend. The difference between proportions was analyzed with Fisher's exact test. Statistical analyses were performed with the Epi Info statistical package, version 7.1.3 for Windows.

Ethical aspects

Individual data on patients reported as having tuberculosis during the period described were delivered to the researchers by the Roraima State Department of Health Tuberculosis Control Program, after the signing of a confidentiality and non-disclosure agreement. The study was approved by the Research Ethics Committee of the Federal University of Roraima (Ruling no. 609,246), which waived the requirement for informed consent because the study used only secondary data.

RESULTS

Between 2005 and 2013, a total of 1,395 cases of tuberculosis were reported in the state of Roraima, Brazil. Of those, 116 (8.3%) were reported as cases of pleural tuberculosis and were included in the present analysis. The mean age of the study population was 39.9 ± 16.6 years. Most patients in the sample were male (n = 82; 70.7%), the most commonly reported level of education was completion of ≤ 9 years of schooling (n = 37; 31.9%), and 12 patients were reported as illiterate (11.1%). Table 1 describes the study sample.

The proportion of reported cases with a high-quality diagnosis was lower in the 2005-2009 period than in the 2010-2013 period, but not statistically significantly so (22.4% vs. 34.5%, respectively; p = 0.67). In addition,

Table 1. Demographic and clinical characteristics of cases of pleural tuberculosis reported between 2005 and 2013, Roraima, Brazil.[a]

Characteristic	Result
Age, years	39.9 ± 16.4
Male gender	82 (70.7)
Level of education	
Illiterate	12 (11.1)
≤ 9 years of schooling	37 (31.9)
High school	25 (21.6)
College	5 (4.3)
No data	37 (31.9)
Race	
Indigenous	21 (18.1)
Non-indigenous	95 (81.9)
Cases reported in the state capital	109 (94.0)
Place of residence	
State capital	66 (56.9)
Rural area	30 (25.9)
Institutionalized in prisons	2 (1.7)
Chest X-ray	
Suspicious (not specified on the reporting form)	105 (90.5)
Not performed	4 (3.5)
Tuberculin skin testing (according to the reporting form)	
Strongly positive	66 (56.9)
Weakly positive	11 (9.5)
Negative	16 (13.8)
Not performed	19 (16.4)
Cases of pleuropulmonary tuberculosis (reported as pulmonary + pleural)	48 (41.4)
Cases of pulmonary + extrapulmonary tuberculosis in a form other than pleural	5 (4.3)
Comorbidities	
AIDS	14 (12.5)
Alcoholism	16 (14.4)
Diabetes	7 (6.3)
Mental illness	5 (4.4)
Positive sputum smear	6 (5.2)
Smear of pleural fluid or a specimen of parietal pleura	
Performed	40 (34.5)
Positive	4 (3.5)
Not performed	74 (63.8)
Culture of pleural fluid or a specimen of parietal pleura	
Performed	54 (46.6)
Positive	3 (2.6)
Not performed	62 (53.5)
Histopathological examination of a specimen of parietal pleura	
Performed	38 (32.8)
Positive or suggestive of tuberculosis	27 (23.3)
Not performed	77 (66.4)
Under way	9 (7.8)
No testing of pleural fluid or specimens of parietal pleura was performed	36 (32.0)

Source: Brazilian Case Registry Database.[11] Developed by the authors, 2014. [a]Values expressed as n (%) or mean ± SD.

there were no statistically significant differences between the 2005-2009 and 2010-2013 groups regarding gender, race, or place of residence. The mean age in the 2005-2009 group was 38.9 years, with a predominance of individuals under 40 years of age (62.0%). In contrast, in the 2010-2013 group, the mean age was 41.1 years, with a predominance of individuals over 40 years of age (55.2%). Table 2 shows the homogeneity of the groups, which minimizes the possibility of interpretation bias in comparing the groups.

Table 2. Comparison between the groups studied. Demographic and clinical characteristics.[a]

Characteristic	Result		p
	2005-2009 group	2010-2013 group	
Age, years	38.9 ± 17.6	41.1 ± 15.1	NS
Male gender	40 (69.0)	42 (72.4)	NS
Race			NS
Indigenous	12 (20.7)	9 (15.5)	
Non-indigenous	46 (79.3)	49 (84.5)	
Place of residence			NS
State capital	36 (62.1)	30 (51.7)	
Rural area	14 (24.1)	16 (27.6)	
High-quality diagnosis	13 (22.4)	20 (34.5)	NS
Other diagnosis	45 (77.6)	38 (65.5)	

Source: Brazilian Case Registry Database.[11] Developed by the authors, 2014. NS: not significant. [a]Values expressed as n (%) or mean ± SD.

The variables gender, age, race, level of education, place of residence, comorbidities, and group (2005-2009 and 2010-2013) did not correlate with the prevalence of cases with a high-quality diagnosis in a univariate analysis. None of the variables met the criterion for inclusion in the multivariate analysis (Table 3).

As shown in Table 3, the only explanatory variable whose prevalence was statistically significant was histopathological examination of a specimen of the parietal pleura (although it was used as a quality-defining criterion, it remained in the table in order to facilitate its comparison with the other criteria), which occurred in 73.7% of the cases (p < 0.001). Smear microscopy of a specimen of the pleural fluid or parietal pleura and culture of the same had prevalences of 35.0% (p = 0.390) and 29.6% (p = 0.838), respectively, among the cases with a high-quality diagnosis in the study sample. For the three aforementioned variables, we performed only a dependence test (Fisher's exact test) in order to avoid possible multicollinearity with the outcome.

DISCUSSION

In 2005, the incidence rate of tuberculosis in the state of Roraima was 36.9/100,000 population, whereas the national incidence rate was 41.4/100,000 population. In contrast, in 2012, Roraima had an incidence rate of 24.5/100,000 population, compared with 37.3/100,000 population nationwide.[11,13] These data reflect the results of the Brazilian National Tuberculosis Control Program in the state, showing that the linear downward trend in incidence was more pronounced statewide than nationwide.

Taking into account cases of extrapulmonary tuberculosis, the incidence rate of tuberculosis in Roraima in 2005 was 8.2/100,000 population, that of pleural tuberculosis being 2.0/100,000 population; in 2013, those rates were 7.9/100,000 and 3.41/100,000 population, respectively, which shows a stabilization of incidence.[11,13] A study conducted by Seiscento et al.,[14] which analyzed epidemiological data on pleural tuberculosis between 1998 and 2005 in the state of

São Paulo, Brazil, showed that there were 118,575 reported cases of tuberculosis during the period studied. Of those 118,575 cases, 25,773 (17.8%) were cases of extrapulmonary tuberculosis, pleural tuberculosis being the form most commonly reported (12,545 cases; 48.7%).

Although the overall incidence of tuberculosis shows a linear downward trend in Brazil and in Roraima, the same is not true when we consider only the pleural form of this disease. This was also reported by Seiscento et al.[14] regarding the trend of tuberculosis incidence in the state of São Paulo, Brazil. Likewise, Baumann et al.[15] presented a comprehensive assessment of the epidemiology of pleural tuberculosis in the USA in 2007, corroborating the evidence from the study conducted by Seiscento et al.[14] Baumann et al.[15] showed that, although the incidence of tuberculosis cases decreased in that country between 1993 and 2003, the incidence of pleural tuberculosis cases remained relatively stable in comparison with the total number of tuberculosis cases. Those authors concluded that the increased difficulty and complexity in diagnosing pleural tuberculosis could lead to underreporting of this presentation of the disease and expressed their concern about this fact. In contrast, according to Seiscento et al.,[14] this stability trend is due to the improvement of diagnostic techniques and the significant number of cases of reactivation in their sample, reactivation being correlated with comorbidities, which were present in 32.0% of the patients with pleural tuberculosis in that sample.

Although the aforementioned authors cited the quality and availability of diagnostic methods as factors impacting the incidence of pleural tuberculosis,[14,15] we found no improvement in the quality of diagnosis as a result of the availability of sample collection techniques and methods used for appropriate diagnosis of tuberculosis within the public health care system in the state of Roraima. The prevalence of cases with a high-quality diagnosis in the 2010-2013 group (which were reported after the establishment of the department of thoracic diseases in Roraima) showed an upward, although not statistically significant, trend relative to

Table 3. Univariate analysis of demographic and clinical data with regard to high-quality diagnosis of pleural tuberculosis, Roraima, Brazil, 2005-2013.

Independent variable	Quality of diagnosis				p	OR (95% CI)
	High		Other			
	n	%	n	%		
Age						
< 40 years	18	29.0	44	71.0	NS	1.06 (0.47-2.38)
≥ 40 years	15	27.8	39	72.2		1
Gender						
Male	25	30.5	57	69.5	NS	1.42 (0.57-3.58)
Female	8	23.5	26	76.5		1
Level of education						
Illiterate	3	25.0	9	75.0	NS	0.71 (0.18-2.89)
Low level of education (up to high school)	21	33.3	42	66.7		1.75 (0.51-5.98)
High level of education (college)	1	20.0	4	80.0		0.54 (0.06-5.11)
Race						
Indigenous	5	23.8	16	76.2	NS	0.75 (0.25-2.24)
Non-indigenous	28	29.5	67	70.5		1
Cases reported in the capital city						
Yes	32	29.4	77	70.6	NS	2.49(0.29-21.55)
No	1	14.3	6	85.7		1
Place of residence						
State capital	21	31.8	45	68.2	NS	1.59 (0.66-3.80)
Urban area	21	27.3	56	72.7		1.14 (0.45-2.89)
Rural area	9	30.0	21	70.0		1
Chest X-ray						
Suspicious	29	27.6	76	72.4	NS	0.67 (0.18-2.45)
Not performed	0	0.00	4	100.0		1
Tuberculin skin testing						
Strongly positive	19	28.8	47	71.2		1.15 (0.49-2.67)
Weakly positive	3	27.3	8	72.7	NS	0.98 (0.24-3.95)
Negative	5	25.0	12	75.0		0.85 (0.25-2.87)
Not performed	4	26.3	14	73.7		0.92 (0.30-2.81)
Comorbidities						
AIDS	2	14.3	12	85.7		0.35 (0.73-1.69)
Alcoholism	4	25.0	12	75.0	NS	0.70 (0.21-2.37)
Diabetes	2	28.6	5	71.4		0.90 (0.17-4.94)
Mental illness	1	20.0	4	80.0		0.55 (0.06-5.09)
Positive sputum smear	1	16.7	5	83.3	NS	0.49 (0.55-4.34)
Smear of pleural fluid or a specimen of parietal pleura						
Performed	14	35.0	26	65.0	NS	-
Positive	4	100.0	0	0.00	0.006	-
Not performed	19	25.7	55	74.3	NS	-
Culture of pleural fluid or a specimen of parietal pleura						
Performed	16	29.6	38	70.4	NS	-
Positive	3	100.0	0	0.0	0.021	-
Not performed	17	27.4	45	72.6	NS	-
Histopathological examination of a specimen of parietal pleura						
Performed	28	73.7	10	26.3	< 0.001	-
Positive or suggestive of tuberculosis	27	100.0	0	0.0	< 0.001	-
Not performed	5	6.5	72	93.5	< 0.001	-
Being in the 2005-2009 group	13	22.4	45	77.6	NS	0.55 (0.24-1.25)
Being in the 2010-2013 group	20	34.5	38	65.5	NS	1.82 (0.80-4.14)

Source: Brazilian Case Registry Database.[11] Developed by the authors, 2014.

that observed in the 2005-2009 group. Nevertheless, the prevalence remained low (at approximately one third of cases with a high-quality diagnosis). This evidence allows us to suggest that patients have limited access to such methods. It is of note that 32.0% of the patients reported as having pleural tuberculosis during the study period did not undergo any testing of pleural fluid or specimens of parietal pleura.

Given the fact that the diagnostic resources are available only in the state capital of Roraima, the prevalence of cases with a high-quality diagnosis would be expected to be higher among patients residing in the capital (56.9%) or among patients who were diagnosed at referral hospitals (83.6%), because of the assumption of greater availability of easy access to sample collection techniques and methods used for the appropriate diagnosis of tuberculosis. However, the prevalence of cases with a high-quality diagnosis was not much higher among the patients residing in the state capital than among those residing in other urban areas (31.8%; p = 0.387 vs. 27.3%; p = 0.784). The results were similar even when only the 2010-2013 group was assessed. This observation suggests the need for new patient referral policies—regionally, locally, and within referral centers—so that health system users can have broad access to the services already offered by the health system.

Although the frequency of reports of pleuropulmonary tuberculosis was found to be 41.4% in our sample, sputum smear positivity was found in only 5.2%. Neither of the two variables had a significant impact on the quality of diagnosis. This finding is a cause for concern, given that pleural tuberculosis is often considered a noncommunicable clinical form. In this context, routine screening for pulmonary involvement is not performed, and patients with pleuropulmonary tuberculosis are labeled as having pleural tuberculosis only. If the patient has active tuberculosis, in the peak period of communicability, the risk, in terms of infection among contacts and in terms of hospital biosafety, merits attention and concern.

Various studies have shown that, if more accurate diagnostic methods, such as imaging tests (tomography), collection of induced sputum or bronchoscopy (bronchoalveolar lavage and biopsy), microbiology (culture), and molecular biology tests, were used, concomitant pleural and pulmonary involvement would be confirmed in 50-80% of patients.[16,17] It should be noted that, despite there being no reference to the use of these methods in a systematic way, the pleuropulmonary form was reported in 18.0% of the patients reported as having pleural tuberculosis in the study conducted by Seiscento et al.[14]

According to the data available on the reporting forms analyzed in this study, routine X-ray was the diagnostic method most often used in order to support the diagnosis, having been used in 96.5% of the cases and the results having been considered suspicious in 90.5%. Tuberculin skin testing was performed in 83.6% of the cases, and the result was positive in 79.4%.

In agreement with the study conducted by Neves et al.,[18] who analyzed the utility of clinical, radiological, and laboratory variables for the diagnosis of pleural tuberculosis, we found that these explanatory variables did not significantly change the quality of the diagnoses in our sample.

The present study has a limitation. Secondary data analysis is prone to confounding factors and inaccuracies. There is no reference on the SINAN reporting form to pleural fluid cytometry, nor is there reference to determination of adenosine deaminase (ADA) or lactate dehydrogenase activity in pleural fluid. This was a limiting factor in the study, since it was not possible to assess the importance of these methods for the quality of the diagnosis of pleural tuberculosis in Brazil. It is of note that, except for determination of ADA activity, which is unavailable in all public diagnostic facilities in the state of Roraima, the other aforementioned tests are available at referral hospitals in the state.

This limitation was also acknowledged in the study conducted by Seiscento et al.,[14] who reported that 55.6% of the 12,545 reported cases of pleural tuberculosis were cases diagnosed on the basis of unspecified criteria, allowing the assumption that diagnoses were based only on clinical-epidemiological or radiological criteria, biochemical criteria, and cytological criteria that were not recorded in the SINAN data set. In our sample, the frequency of such cases was 71.6%, a worrisome figure when it comes to the reliability of the diagnoses.

It has been observed that, in countries with a high incidence of tuberculosis, an epidemiological history suggestive of exposure, together with elevated protein levels, a lymphocyte/neutrophil ratio > 0.75), and, especially, ADA activity in pleural fluid > 40 U/L, is sufficient to warrant the initiation of treatment,[18,19] especially because highly specific tests can take weeks to produce results.

In view of the fragility of diagnoses in the state of Roraima, the findings of the present study allows us to suggest that determination of ADA activity in pleural, pericardial, and peritoneal fluid should be made available within the public health care system. This suggestion is not intended to replace bacteriological and histopathological methods but rather to provide grounds for the institution of treatment of tuberculosis while tests that are more specific are being processed. Likewise, it is advisable to include a field for reporting the use of the suggested method on the reporting form.

Taking into account the tests recommended by the Brazilian National Tuberculosis Control Program as the tests of choice for a definitive diagnosis of pleural tuberculosis as well as the defining criteria for high-quality diagnosis, the present study can say that bacteriological tests were ordered in 59.5% of the cases, yielding positive results in only 11.2%. Smear microscopy of sputum, pleural fluid, or pleural specimens was positive in only 5.7% and 3.5% of the reported cases, respectively, and culture of the same material

was positive in 2.6%. The fact that smear microscopy and culture of pleural fluid or pleural specimens were requested had no statistically significant impact on the quality of diagnosis.

In the sample studied by Seiscento et al.,[14] bacteriological tests were used in 44.4% of the cases. Approximately 14% of those cases had bacteriological confirmation (positive sputum smear, in 5.6%; positive smear of pleural fluid/pleural tissue, in 3.0%; and positive culture for *M. tuberculosis*, in 5.6%). In contrast, in the sample studied by Baumann et al.,[15] 62.8% of the cases of pleural tuberculosis had at least a culture of tissue/fluid that was positive for *M. tuberculosis*, and 1.7% were sputum smear positive. Those authors acknowledged concern about underreporting owing to decreased yields when only pleural fluid is analyzed.

Histopathological examination of pleural specimens was performed in 32.8% of the reported cases of pleural tuberculosis in the present sample, being positive in 23.3%. The prevalence of having undergone this test among the cases with a high-quality diagnosis was 73.7%. In addition, of the 6 cases in which the diagnosis was changed, 2 underwent histopathological examination, which emphasizes the importance of the method not only to confirm clinical suspicions, but also to establish differential or perhaps comorbid diagnoses. Histology of the pleura was decisive for diagnosis in 30.2% of the reported cases of the disease in the sample studied by Seiscento et al.[14] In contrast, in the sample studied by Baumann et al.,[15] 15.8% of the patients with pleural tuberculosis had a positive result from microscopic examination of pleural tissue, without the criteria for positivity being defined.

We found no data on the clinical progression of the patients treated as having pleural tuberculosis in the SINAN records—only data on treatment outcomes (cure, noncompliance, death, transfer out, change in diagnosis, and multidrug-resistant tuberculosis).[12] Therefore, the fact that there were only 6 cases (5.2%) in which the diagnosis was changed does not ensure that the cases whose diagnosis was based on clinical and radiological criteria, representing most of the sample (71.6%), were actually cases of pleural/pleuropulmonary tuberculosis rather than cases of other diseases that also have pleural involvement.

On the basis of our findings, we conclude that poor quality of diagnosis and limited access of patients to appropriate diagnostic methods result in chronic exposure of the population in Roraima, which has a high prevalence of individuals who are more susceptible to developing tuberculosis, chief among whom are those in indigenous and prison populations. These populations are exposed to the possibility of undergoing long treatments and suffering their potential complications, without a reliable diagnosis. In addition, more disastrously, individuals other than those mentioned above can also have severe, permanent, occupationally limiting pulmonary and pleural sequelae, leading even to death, as a result of delayed or no treatment because of a lack of diagnosis. Furthermore, these facts often perpetuate the chain of disease transmission, which has major consequences for public health and for health care professionals (biosafety).

It is also possible to conclude that the recent provision of services and diagnostic procedures for thoracic diseases in the state of Roraima has not translated to improved quality of diagnosis among the reported cases of pleural or pleuropulmonary tuberculosis. It is therefore evident that there is a need for further studies that will complement the present study, as well as for the development and implementation of public policies that increase the quality of diagnosis and the access to diagnostic methods.

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