Epidemiological and Laboratorial Profile of Patients with Isolation of Nontuberculous Mycobacteria

Heloisa Silveira Paro Pedro¹, Andréa Gobetti Vieira Coelho², Isabela Mauzo Mansur², Ana Carolina Chiou², Maria Izabel Ferreira Pereira¹, Naiara Cristina Ule Belotti¹, Manuela Galloy Sanches Ismael¹, Maria Rita de Cásia Oliveira Cury¹, Susiline Maria Tonelli Hardt¹, Erica Chimara²

¹Instituto Adolfo Lutz, Núcleo de Ciências Biomédicas, Laboratório de Micobactérias do Instituto Adolfo Lutz, de São José do Rio Preto, SP Rua Alberto Sufredine Bertoni, 2325, Maceno, São José do Rio Preto, ²Instituto Adolfo Lutz, Núcleo de Ciências Biomédicas, Laboratório de Micobactérias do Instituto Adolfo Lutz de Santos, SP Rua Silva Jardim, 90, Vila Matias, Santos, ³Mercator, Rua Voluntários de São Paulo 3439, São José do Rio Preto, ⁴Ambulatório de Tuberulose e Hanseníase, Tv. Tambo, 3571, Vila Flores, São José do Rio Preto, ⁵Instituto Adolfo Lutz, Núcleo de Tuberulose e Micobacterioses, IAL Central São Paulo, SP Av. Dr. Arnaldo, 355, Cerqueira César, São Paulo, Brazil

Abstract

Background: An increase in NTM diseases in the international scenario has been observed in recent years. Aims: To analyze the epidemiological and laboratory profiles of patients with isolation of nontuberculous mycobacteria (NTM) over one decade. A retrospective analysis of records of a mycobacterial reference laboratory found 135 cases with isolation of NTM. Methods: Clinical and epidemiological data were collected from the records of government health clinics and from the State notification system (TBWEB). The cases were geocoded by location based on the street address in the Mercator Transverse Universal projection, Datum SAD/69 and MapInfo software. Results: Most patients were male (66.7%), older than 50 years (40%) and had only completed elementary schooling (38.5%). Associated health problems were found in 71.8% of the subjects, with 43.7% being HIV positive and 25.9% having had tuberculosis in the past. Hospitals were the most able institutions on the street address in the Mercator Transverse Universal projection, Datum SAD/69 and MapInfo software. Results: Most patients were male (66.7%), older than 50 years (40%) and had only completed elementary schooling (38.5%). Associated health problems were found in 71.8% of the subjects, with 43.7% being HIV positive and 25.9% having had tuberculosis in the past. Hospitals were the most able institutions to diagnose cases (45.2%). Sputum was the most common material tested (63.0%) with the bacilloscopy being positive in 33.3% of cases. The most common mycobacteria species in the region were Mycobacterium avium and M. abscessus/M. massiliense/M. bolletii. When the regional reference municipality was analyzed, M. avium and M. fortuitum were the most common species isolated in the urban area. Conclusions: In the study region, mycobacteriosis most affected adult males with low schooling. Most patients presented comorbidities in particular coinfection with the HIV virus. M. avium is the most prevalent species in the region with the M. abscessus/M. massiliense/M. bolletii species being the main cause of nosocomial infections.

Keywords: Clinical laboratory techniques, epidemiology, Mycobacterium avium, nontuberculous mycobacteria, retrospective analysis

Introduction

Nontuberculous mycobacteria (NTMs) are widely dispersed in the environment, in natural and drinking water, and in soil and aerosols; they have already been isolated in several animal species and from different sites of the human body.[1] The importance of diseases caused by NTM has been increasing progressively,[1-5] mainly due to the improvement in the diagnosis of mycobacteria, with the typification of different species that were previously difficult to identify.[4]

Despite the increase in the number of species isolated, the true clinical significance of each is still very difficult and controversial. Most species are saprophytic and replicate in natural environments; however, a few adapt to the intracellular environment and can cause disease.[6]

Since human is not the host of choice for NTM, infections are opportunistic.[7] Thus, environmental sources, such as inoculation through trauma, inhalation of aerosols,[8] and contaminated medical instruments, are the most common forms of transmission.[9] Several factors may lead to increased susceptibility to NTM infection, in particular preexisting lung disease, immunosuppression, and genetic defects related to cell-mediated immunity.[9]

Address for correspondence: Dr. Heloisa Silveira Paro Pedro, Núcleo de Ciências Biomédicas, Laboratório de Micobactérias do Instituto Adolfo Lutz de São José do Rio Preto, SP Rua Alberto Sufredine Bertoni, 2325, Maceno, São José do Rio Preto, São Paulo Brazil E-mail: hsppedro@ial.sp.gov.br

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In Brazil, as in most developing countries, the routine diagnosis of mycobacteriosis is based on direct microscopic examination of sputum and cultures, the most sensitive method, especially in samples from paucibacillary patients. NTM isolation from nonsterile clinical specimens may mean transient colonization or contamination and not necessarily disease; thus, clinical-laboratory diagnosis is important to confirm mycobacteriosis and to establish the therapeutic strategy.

NTM isolation rates are quite different between the Brazilian regions. In São Paulo State, there are differences in isolation frequencies, with predominance of Mycobacterium avium and Mycobacterium kansasii in different municipalities.

This study aimed to analyze the epidemiological and laboratory profiles of patients with NTM infections over one decade in an important region of São Paulo State.

**Methods**

This retrospective study included all patients with NTMs living in 102 municipalities that constitute the XV Regional Health Department of São José do Rio Preto (SJRP) tested by the Adolfo Lutz Institute of São José do Rio Preto (IAL-SJRP) from 2000 to 2009. IAL-SJRP is a regional reference laboratory for the diagnosis of mycobacteria.

The regional reference municipality (SJRP) is in a region that borders two other states and is an important administrative, medical, service center. It has a high acquired immunodeficiency syndrome (AIDS) coefficient, which influences the prevalence of tuberculosis (TB).

Patients were identified from records of the Mycobacteria Laboratory of IAL-SJRP. Subsequently, clinical and epidemiological data were retrieved from medical records from government health clinics and the São Paulo State Notification System-TBWEB (http://www.cvetb.saude.sp.gov.br/tbweb/).

Analysis of the clinical, epidemiological, and laboratory profile of patients was based on sex, age, other associated pathological conditions, schooling, profession, address, clinical specimen, bacilloscopy results, isolated NTM species, number of isolates, history of TB, treatment given, X-ray results, diagnostic criteria, notification at TBWEB, and type of closure of the case.

Pulmonary and extrapulmonary clinical specimens were included. According to the bacteriological criteria established by the American Thoracic Society, a patient has mycobacteriosis when the same infectious agent is identified in more than one sample from a nonsterile site or is identified in only one sample from a sterile site. Due to the large number of cases, patients with single isolates from a nonsterile site were included in the study if they had clinical criteria compatible with the disease or an X-ray suggestive of TB.

For the classification of cases, over 15-year-old patients with laboratory diagnosis confirmed by culture and conclusive identification of NTM were considered “confirmed cases” of mycobacteriosis. Patients with only one nonsterile site isolation without the clinical criteria or an X-ray suggestive of the disease were considered “suspected cases” and included in the overall analysis.

Bacilloscopy and cultures were performed at IAL-SJRP according to the methodology recommended by the Brazilian Ministry of Health. Bacterial identification was performed at the Central IAL in São Paulo using the polymerase chain reaction-restriction enzyme analysis (PRA-hsp65) method and phenotypic identification.

The designation of the group “Mycobacterium abscessus/Mycobacterium massiliense/Mycobacterium bolletii” was used because some isolates were identified only based on phenotypic evidence, which does not differentiate between these species.

Statistical analyses used the Epi-Info statistical software version 7.2.1.0 (Atlanta, Geórgia, EUA). All cases were geocoded by location based on street address in the Universal Transverse Mercator projection, Datum SAD/69 made available by the city hall of SJRP. Mapinfo software tools were used to prepare thematic maps.

This study is part of a research project (Protocol number is 136487/2010).

**Results**

In the period from 2000 to 2009, isolates of NTMs were found in 135 patients; 74 (55%) were registered from 2000 to 2003. The study population was predominantly male, older than 50 years, and presented some type of associated comorbidity [Table 1].

**Notification of cases**

TBWEB notification occurred for 94 (69.6%) patients with 5 (3.7%) being notified twice. Notification is made based on positive NTM bacilloscopy results updated in cases of mycobacteriosis. In these cases, the natural outcome is a change in the diagnosis as found for 32 (23.7%) patients. However, other outcomes were found: 34 (25.2%) cases of cure, 11 (8.1%) cases of death from other causes, two (1.5%) deaths due to TB, one (0.7%) case abandoned treatment, one (0.7%) case transferred, and for 13 (9.6%) patients, there was no closure despite the notification.

Hospitals had the highest percentages of diagnosis (45.2%; n = 61) and notifications (49.2%; n = 30). Specialist outpatient clinics diagnosed 44 cases (32.6%) and notified 40 (90%), first aid posts diagnosed 6 (4.4%) cases and notified all of them, and 16 (11.9%) cases were identified in government health clinics that notified 12 (75%). This information was missing from 8 (5.9%) medical records.

The mean duration of treatment for mycobacterial cases was 15 months (range: 34–1700 days) from the release of the microorganism identification report to the conclusion of the case on the TBWEB.
Analysis of medical records

Information on occupations was found in 43% (n = 58) of the cases: construction workers 29.3% (n = 17), self-employed 20.7% (n = 12), registered employees 19.0% (n = 11), agricultural workers 13.8% (n = 8), housecleaners 10.4% (n = 6), retired 1.7% (n = 1), two students (3.4%), and one homeless (1.7%). Regarding previous history of illness, 35 patients (25.9%) had had TB. The mean time between the TB and the discovery of NTM varied from 5 months to 60 years (mean 6.6 ± 11.7 years; median 3.0 years).

Among the cases evaluated, 60 (44.4%) had X-rays with suspicion of TB and 20 (14.8%) with suspicion of TB with cavity. However, 14 (10.4%) did not perform an X-ray, 19 (14.1%) had no information on X-rays, and 12 (8.9%) had normal X-rays, and for 10 (7.4%), the X-ray identified other conditions.

Table 1: Clinical and sociodemographic characteristics of patients with isolation of nontuberculous Mycobacteria in the XV Regional Health Department in São Jose do Rio Pre to during the period 2000–2009

| Sociodemographic characteristic | n (%) |
|-------------------------------|------|
| Sex                           |      |
| Female                        | 45 (33.3) |
| Male                          | 90 (66.7) |
| Age range (years)             |      |
| 15-35                         | 32 (23.7) |
| 36-50                         | 48 (35.6) |
| >50                           | 54 (40) |
| Unknown                       | 1 (0.7) |
| Schooling                     |      |
| Illiterate                    | 7 (5.2) |
| Elementary school             | 52 (38.5) |
| High school                   | 20 (14.8) |
| Further education             | 2 (1.5) |
| Unknown                       | 54 (40) |
| Diagnosis of HIV              |      |
| Positive                      | 59 (43.7) |
| Negative                      | 52 (38.5) |
| Examination not performed     | 9 (6.7) |
| Unknown                       | 15 (11.1) |
| Associated health problems*   |      |
| Yes                           | 97 (71.8) |
| No                            | 25 (18.6) |
| Unknown                       | 13 (9.6) |
| Classification of the case    |      |
| Suspected                     | 7 (5.2) |
| Confirmed                     | 128 (94.8) |
| Notification on TB-Web        |      |
| Notified                      | 94 (69.6) |
| Nonnotified cases             | 41 (30.4) |

*Diabetes, HIV, smoker, alcoholism, mental illness, syphilis, hepatitis B, hepatitis C, neoplasms, renal disease, pulmonary fibrosis, pneumonia, neurotoxoplasmosis, hypertension, lung neoplasm, lung lobectomy, gastritis, cirrhosis, lung disease, Alport syndrome, esophagitis, peripheral neuropathy, herpes simplex. TB-Web: Tuberculosis

For cases that recorded the time between the onset of symptoms and the diagnosis of NTM (n = 58), the mean time between events was 83.5 days (range: 6–660 days).

Of the 135 patients, 76 (56.3%) were not treated for mycobacteriosis and 18 (13.3%) had no information on the drug used for the treatment. Of the 41 (30.4%) patients who were treated for NTMs, three were treated with regimen I (rifampicin, isoniazid, and pyrazinamide), eight were treated with the IR regimen (rifampicin, isoniazid, pyrazinamide, and ethambutol) and thirty were treated with alternative regimens that associated or included other drugs such as ciprofloxacin, amikacin, clofazimine, azithromycin, cephalaxin, and clarithromycin. Clarithromycin was used in 14 patients.

Laboratory analysis

The total number of patients with positive bacilloscopy was 45/135 (33.3%); most tested sputum.

The results showed that M. avium was the most frequently isolated species (33.3%). However, frequency analysis from year to year showed that the isolation of this species was decreasing, whereas the isolation of the M. abscessus/M. massiliense/M. bolletii group increased from 2007 [Figure 1]. Of the 24 cases of M. abscessus/M. massiliense/M. bolletii in bronchial lavage, 20 were from the same hospital, isolated in 2008 (n = 5) and 2009 (n = 15).

All 13 (9.6%) cases with disseminated disease were HIV positive; M. avium was isolated in 11 cases, M. kansasii in one, and Mycobacterium fortuitum in one; five patients had concomitant Mycobacterium tuberculosis (MT) and NTM isolated from sputum; four were HIV positive, three of whom were also drinkers and one took cocaine [Table 2].

More than one NTM isolate was obtained from 47 patients; the same species was identified in different isolates in 63.8% (30/47) of the patients and different species were found in 36.2% (17/47) of the patients. The maximum number of isolates in one individual was four, observed in 10.6% (5/47) of the cases.

It was not possible to confirm mycobacteriosis in 5.2% of the patients (n = 7), who were classified as “suspected cases” due to one isolation of NTM from a nonsterile site and absence of clinical and radiological findings in the medical records.

Figure 1: Frequency of isolation of mycobacteria species at the Adolfo Lutz Institute, São José do Rio Preto from 2000–2009
Table 2: Clinical and bacteriological characteristics of the cases with concomitant isolation of *Mycobacterium tuberculosis* and nontuberculous *Mycobacteria*

| Case | Age | Sex | HIV positive | Associated problem | n isolates | 1st isolate | 2nd isolate | 3rd isolate |
|------|-----|-----|-------------|-------------------|------------|-------------|-------------|-------------|
| 1    | 31  | Female | Yes | Smoker/cocaine | 3 | Negative | MT | Positive | M. avium |
| 2    | 41  | Male   | Yes | Alcoholic      | 2 | Positive | M. avium | Positive | M. avium |
| 3    | 31  | Male   | Yes | Alcoholic      | 3 | Negative | M. intracellulare | Negative | M. triviale |
| 4    | 44  | Male   | No  | -               | 3 | Negative | MT and M. gordonae | Negative | M. gordonae |
| 5    | 41  | Male   | Yes | Alcoholic      | 2 | Negative | M. peregrinum | Positive | MT |

Bac: Bacilloscopy, Ident: Identification, NP: Not performed, MT: Mycobacterium tuberculosis, M. avium: Mycobacterium avium, M. intracellulare: Mycobacterium intracellulare, M. gordonae: Mycobacterium gordonae, M. peregrinum: Mycobacterium peregrinum, M. triviale: Mycobacterium triviale

Table 3: Absolute n (%) of nontuberculous *Mycobacteria* species isolated between 2000 and 2009 from patients of Dispositional Resilience Scale

| Identified Species                                      | Sputum | Blood | Aseptic organic liquid | Secretions in general | Broncoalveolar lavage | Ganglion aspiration | Total |
|--------------------------------------------------------|--------|-------|------------------------|-----------------------|-----------------------|---------------------|-------|
|                                                        | n      | %     | n                      | %                     | n                      | n                   | %     |
| M. avium                                               | 29     | 21.5  | 10                     | 7.4                   | 1                      | 0.7                 | 2.2   | 1.5   | 45    | 33.3  |
| M. abscessus/M. massiliense/M. bolletii                | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0.7   | 0     | 23    | 17.1  |
| M. fortuitum                                           | 7      | 5.2   | 1                      | 0.7                   | 1                      | 0.7                 | 2     | 1.5   | 0     | 12.0  |
| M. gordonae                                            | 8      | 5.9   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 5.9   |
| M. abscessus                                           | 4      | 3.0   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 3.0   |
| M. intracellulare                                      | 2      | 1.5   | 0                      | 0                     | 0                      | 0                   | 0     | 2.2   | 0     | 1.5   |
| M. chelonae                                            | 2      | 1.5   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.5   |
| M. terrae                                              | 2      | 1.5   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.5   |
| M. flavescens                                          | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. neoaurum                                            | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. shimoidei                                           | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. shilae/M. mucogenicum/M. nonchromogenicum           | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. avium + MT                                          | 2      | 1.5   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.5   |
| M. avium + M. fortuitum                                | 2      | 1.5   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 3.2   |
| M. avium + M. abscessus                                | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. avium + M. kansasi                                  | 0      | 0     | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. abscessus + CLA                                      | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. abscessus + M. cheloneae                            | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| MT + M. peregrinum                                     | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. malmoense + M. shimoidei + CLA                       | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. intracellulare + M. triviale + MT                   | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. terrae + M. triviale                                | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. gordonae + CLA                                       | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. gordonae + M. triviale                              | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| M. fortuitum + M. gordonae                             | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| MT + M. gordonae                                       | 1      | 0.7   | 0                      | 0                     | 0                      | 0                   | 0     | 0     | 0     | 1.7   |
| Total                                                  | 85     | 63.0  | 13                     | 9.6                   | 3                      | 2.2                 | 4     | 3.0   | 28    | 20.7  |

-15 in São José do Rio Preto according to the site of isolation. MT: Mycobacterium tuberculosis, NTM: Nontuberculous Mycobacteria, CRA: Fast-growing achromogenic Mycobacterium, CLA: Slow-growing achromogenic Mycobacterium, CLE: Slow-growing scotochromogenic Mycobacterium
The high mean age of the patients with mycobacteriosis with the majority being male shows a similar profile to that reported in the literature.15,18,22,25,26 Here is, however, a paucity of studies analyzing the schooling and profession of patients perhaps because profession is rarely included in medical records.

It is not mandatory to notify mycobacteriosis in Brazil, except for cases of fast-growing mycobacteria after surgery. Although 30.4% of the cases were not reported, the high percentage of cases reported to the TBWEB system without a “change of diagnosis” reveals that the patient is probably not being treated adequately.

The highest percentage of cases diagnosed in this study was discovered at tertiary care hospitals where the patient is usually diagnosed in a serious condition. This suggests that the diagnosis had been delayed, a fact that may explain the long time between the onset of symptoms and the date of diagnosis.

Although chronic lung disease is the most common clinical manifestation of NTMs,27 the decision to treat patients who have symptoms is still a concern since the identification of mycobacteria can take days or weeks. In the 1950s, with the introduction of effective treatment for TB, cultures became routine and it was found that some cases diagnosed as TB were in fact NTMs.17 The medical records in this study showed that although the initial diagnosis based on clinical and radiological symptoms suggested TB, a species of NTM was found, showing the importance of identification for a satisfactory outcome.

More than half the patients did not receive NTM treatment (56.3%), a fact that is not investigated in this study. This suggests that the physician’s decision was not to carry out treatment when there is only one isolate from a nonsterile site. Studies show that many patients do not treat mycobacteriosis.21,28 For patients that were treated in this study, the treatment time varied probably because therapy is complex as NTMs are naturally resistant or have low sensitivity to TB drugs and have different patterns of resistance.24,29 The types of drugs used in these patients are those recommended by the national literature.30

The high occurrence of NTM cases before 2003 can possibly be explained by the introduction of highly active antiretroviral therapy, which reduced the number of cases of disseminated disease in the region.

The percentage of positive bacilloscopies (33.3%) was higher than those found in studies in India (20%)31 and Greece (10%)32 but lower than one study carried out in Italy (53.3%).33 As generally the bacilloscopy is negative and the result of the culture takes a long time, the patient may no longer be found to treat mycobacteriosis after being discharged.32

M. avium, a slow-growing NTM, was responsible for 33.3% of all cases. Other studies reported that this agent was prevalent in isolations of NTMs.4,7,12,22,26,27,34,36 M. avium can cause
disease in individuals with or without previous lung disease.\textsuperscript{[37]} Disseminated disease can occur in patients with AIDS and in patients with abnormalities of the interleukin-12 and interferon gamma receptors.\textsuperscript{[38,39]} In the present study, the occurrence of disseminated disease caused by \textit{M. avium} was found in 11 cases, all of which were HIV positive. It was not possible to establish an epidemiological connection between the cases of \textit{M. avium} due to their occurrence in diverse and unrelated sites.

Isolation of the \textit{M. abscessus}/\textit{M. massiliense}/\textit{M. bolletii} group in the bronchoalveolar lavage of individuals from the same hospital, mostly in 2009, suggests an outbreak. This rapidly growing mycobacterium is commonly associated with outbreaks of nosocomial infections after invasive procedures,\textsuperscript{[40,41]} probably due to failure in the disinfection process and not to sterilization.\textsuperscript{[42]} The analysis of the geographical distribution of NTMs around the world and the possible sources of infection may be the guiding principles for the prevention of the disease.\textsuperscript{[43]}

There is geographic variability in the prevalence and distribution of species responsible for diseases caused by NTMs in São Paulo State, such as \textit{Mycobacteria gordonae}.\textsuperscript{[25]} \textit{M. kansasii}, and \textit{M. avium}.\textsuperscript{[13]} In this study region, the most frequent species was \textit{M. avium} in sputum, followed by \textit{M. abscessus}/\textit{M. massiliense}/\textit{M. bolletii} in bronchoalveolar lavage; another common species was \textit{M. fortuitum}. This species has been reported as an agent of pulmonary diseases but mainly in cases of infections after surgery and related to the use of catheters.\textsuperscript{[44,45]} On the contrary, one study conducted in the Middle East found that \textit{Mycobacterium chelonae} 50% was the most common among fast-growing NTMs with \textit{Mycobacterium simiae} (42.8%) being the most frequent among slow-growing NTMs.\textsuperscript{[46]}

The majority of carriers of NTM isolates from nonsterile materials presented only one positive culture for mycobacteria, which may characterize transitory contamination or colonization.\textsuperscript{[12]} However, patients with single isolates presented clinical findings compatible with disease and/or an association with other comorbidities that may affect the immune system. Other confirmatory criteria such as positive bacilloscopy or radiological diagnosis were also observed. Previous studies in our region reported the same difficulty in relation to the number of isolates in nonsterile samples\textsuperscript{[14,47]} as have other authors.\textsuperscript{[5,12]} This fact shows one operational difficulty in the diagnosis of NTM in Brazil that recommends the request for new samples to confirm cases.

The occurrence of mixed infections of MT with other mycobacteria may have occurred due to the HIV status of four of these patients. However, the presence of MT and \textit{M. gordonae} in an immunocompetent patient may have occurred due to sample contamination as \textit{M. gordonae} is rarely correlated to the disease.\textsuperscript{[25]} We should remember that the lesion caused by MT is an open door for mycobacteriosis. Therefore, knowing the TB history of patients is important for the suspicion of NTM infections. In a study in Pará, Brazil, Fusco da Costa \textit{et al.}\textsuperscript{[48]} found a 76% risk for lung disease due to NTMs in patients who had had TB. As in this study, Lima \textit{et al.}\textsuperscript{[49]} in Rondônia, Brazil, found the presence of more than one NTM species in the same patient and found three cases of NTM and MT coinfection.

Among the limitations of the study, we must highlight those resulting from incomplete records, making the analysis of variables difficult.

**CONCLUSION**

Mycobacteriosis mainly affects men, over 50-year olds, and individuals with a low level of schooling.

Most patients present an associated pathology, with coinfection by the HIV virus being the most common.

The laboratory profile showed a regional panorama of NTM species with two realities. the first presents \textit{M. avium} as the prevalent species, and in a population with a high incidence of HIV, its identification is mandatory to establish the correct therapy. The second reality reflects the region’s characteristic of being an important medical and service center, in which the \textit{M. abscessus}/\textit{M. massiliense}/\textit{M. bolletii} species are the main cause of nosocomial infections. This shows that surveillance should be increased as a preventive measure.

NTMs may be underdiagnosed because of the difficulty in obtaining data to establish the disease or simply because it is a transient infection or colonization.

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**Conflicts of interest**

There are no conflicts of interest.

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