Mycobacterium xenopi: Evidence for Increased Rate of Clinical Isolation

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ABSTRACT

In light of recent reports of increased isolation of M. xenopi, we reviewed the number of M. xenopi isolates in a hospital setting over five years. A total of 133 isolates from 100 patients were reported, of these isolates, 8 were reported over the first two years, 21 isolates in the third year, 47 isolates in year four and 57 isolates in year five. The specimen sources were mainly respiratory specimens; however a few specimens were isolated from other sources. Clinical data on 12 patients with repeated isolates are presented. Patient conditions upon admission and previous medical histories are shown and compared to earlier reports. An increased awareness of the presence of this organism is necessary since the clinical presentation of patients with M. xenopi can be confused with tuberculosis. (Int J Biomed Sci 2009; 5(2):96-100)

Keywords: Mycobacterium; xenopi; non-tuberculous mycobacteria (NTM); HPLC

INTRODUCTION

There is a growing interest in the diagnosis of potentially pathogenic non-tuberculous Mycobacteria (NTM) (1). This interest was fueled by an increasing number of NTM cases and by the similarity between some of the NTM infections and infections by M. tuberculosis (2, 3). Among NTMs of particular interest is Mycobacterium xenopi, which has been a common isolate in Europe and Middle East (4-7). This organism is becoming increasingly isolated in certain areas of USA (4, 8, 9). M. xenopi is a slow-growing scotochromogenic Mycobacterium which resembles MAI when tested by biochemical reactions. However it is negative for MAI probe, grows best at 42°C, # does not grow at 25°C (4), and it has a distinct mycolic acid pattern (10).

In this paper, we report a dramatic increase in the number of M. xenopi isolates reported over a five year period, and review the clinical data of patients from whom multiple isolates were obtained.

MATERIALS AND METHODS

Data Collection and Analysis

Records of Mycobacterium culture results at Kings County Hospital Center (KCHC) were reviewed for positive M. xenopi cultures during a five year period after 1990. Specimen numbers were listed in Microsoft Works database. Subsequently specimen and patient information were obtained and entered in the same database. Queries were made to obtain the number of isolates and the number of patients with M. xenopi for each month. A Microsoft Works spreadsheet was used to tabulate the data.
Specimen Processing
Non-sterile specimens, such as sputum and bronchial lavage, were digested and decontaminated using NaOH/NALC (N-Acetyl Cysteine) (11). The final concentrate was suspended in buffer and inoculated into Bactec 12B medium and/or a Mycobacterium growth indicator tube and a selective 7H11 agar plate. All cultures were incubated at 37°C and screened twice during the first two weeks and once weekly after the second week. When culture was positive, an AFB stain was performed, and the isolate was identified as described below.

Culture Identification
Positive AFB cultures were screened first for M. tuberculosis and Mycobacterium avium-intracellulare (MAI) using Gen-Probe. If both probes were negative, cultures were identified mainly by high performance liquid chromatography (HPLC), based on the method described by Butler et al. (10, 12). Briefly, mycolic acids were extracted from 1-2 loopfuls from colonies according to CDC standards, and the final extract of mycolic acids was suspended in 100 µL of methylene chloride and analyzed by HPLC using a C-18 Ultrasphere-X-L analytical column and a mobile phase consisting of a changing gradient. The gradient of methanol and methylene chloride began at 98% and 2% respectively, then changed to 80% and 20% for 1 minute, then changed to 35% and 65% for the following 10 minutes. Chromatograms were analyzed by Piruette software to predict the nearest match from the CDC mycolic acid library. Colonial morphology and growth rate were evaluated for conformation. Chromatogram of M. xenopi isolated in our laboratory (not shown) was similar for isolates identified by HPLC elsewhere (10, 12).

RESULTS

Frequency of NTM Isolation
In order to determine if there is an increasing trend in the isolation of NTM, we reviewed positive Mycobacterium cultures over a five year period at KCHC. A total of 12747 specimens were received in year 1, 10500 in year 2 and 8500 in year 5 (Table 1). The percentages of Mycobacterium tuberculosis (MTB) isolates of all specimens received, for the years one, two and five, were 8.7%, 7.5%, and 5.3%, and the percentages of Mycobacterium avium-intracellulare (MAI) isolates were 6.9%, 10.3%, and 10.6%, respectively. The sharpest increase was observed in NTM group other than MAI, which was 0.9% of all cultures in year one, 1.5% in year two and 3.2% in year five.

Review of the Number of M. xenopi Cases
The high proportion of M. xenopi isolates in the NTM group prompted us to look further back to track when the number of isolates started to rise and to determine if there is any clinical significance to these isolates. During the five year period, 133 isolates from 100 patients were reported. Table 2 shows the distribution of isolates from these 100 patients in each year. A total of 3 patient were found in year one, 5 patients in year two, 21 patients in year three, 47 patients in year four and 57 patients in year five. 125 M. xenopi isolates were recovered from respiratory sources (sputum, bronchial lavage and bronchial biopsy), 4 isolates from urine, 1 isolate from stool and 3 isolates from body sites that are expected to be sterile.

Table 1. Percent of Mycobacterium isolates

|          | 1  | 2  | 5  |
|----------|----|----|----|
| Total Specimens | 12747 | 10500 | 8500 |
| Negative cultures | 83.5% | 80.7% | 80.9% |
| MTB isolates | 8.7% | 7.5% | 5.3% |
| MAI isolates | 6.9% | 10.4% | 10.6% |
| Other NTM isolates | 0.9% | 1.5% | 3.2% |

Records of Mycobacterium cultures at Kings County Hospital were reviewed for a five year period. The total number of specimens received for each year is shown. The table also presents the percentages of negative cultures, positive M. tuberculosis (MTB) cultures, positive M. avium-intracellulare complex (MAI) cultures and other positive nontuberculous mycobacteria (NTM) for each of the years listed.

Table 2. Specimen sources of M. xenopi isolates

|          | 1 | 2 | 3 | 4 | 5 | Total |
|----------|---|---|---|---|---|-------|
| Sputum   | 3 | 5 | 19 | 38 | 51 | 116   |
| Bronchial lavage | 0 | 0 | 1 | 2 | 4 | 7    |
| Bronchial biopsy | 0 | 0 | 0 | 1 | 1 | 2    |
| CSF      | 0 | 0 | 1 | 0 | 0 | 1    |
| HIP      | 0 | 0 | 0 | 1 | 0 | 1    |
| Pericardium | 0 | 0 | 0 | 1 | 0 | 1    |
| Urine    | 0 | 0 | 0 | 3 | 1 | 4    |
| Stool    | 0 | 0 | 0 | 1 | 0 | 1    |
| Total    | 3 | 5 | 21 | 47 | 57 | 133  |

M. xenopi positive cultures from each specimen source was recorded over a five year period. The total number of all isolates from a particular specimen source is shown (vertical), as well as the total number of isolates for each year (horizontal).
Review of Clinical Data of 12 Patients with Repeated M. xenopi Isolates

In the light of our observation of an increase in M. xenopi isolation, we reviewed the clinical presentation of patients from which repeated isolates of M. xenopi were found. Although M. xenopi was reported in 100 patients over a five year period, only 16 patients were found to have repeated isolates or isolates from normally sterile sites. Among these 16 patients, relevant clinical data for only 12 patients was available for review. As shown in table 3, seven patients were males with a mean age of 50 years (range, 28-76 years) and 5 patients were females with a mean age of 33 years (range, 28-40 years). M. xenopi was isolated from respiratory specimens in 10 patients (cases 1-10), from pericardial fluid in case 11, and from CSF in case 12.

Nine patients were admitted with fever (cases 1, 3, 5, 7-12). Among these 9 patients, 7 patients had cough with (cases 1, 3, 5, 7, 10) or without night sweats (cases 8, 9). Other symptoms included weakness (cases 1-6, 8, 10), shortness of breath (SOB) (cases 4, 7-9), weight loss (cases 7, 9, 11), chest pain (cases 9, 11), hemoptysis (case 4), and headache (case 12).

The most common radiographic finding was an interstitial infiltrate (cases 5, 7-9). Other radiographic presentations included reticulonodular infiltrate (cases 1, 4), bilateral hilar adenopathy (cases 5, 6), upper lobe lesions (cases 2, 3), calcified granuloma (case 11), and mediastinal adenopathy (case 12).

Review of the medical history revealed that 6 patients had AIDS (cases 4-9). Five of the AIDS patients (cases 4, 5, 7-9) also had Pneumocystis carinii pneumonia (PCP) and 3 had concurrent isolation of other Mycobacterium species (cases 5, 7, 9). Two patients had chronic obstructive pulmonary disease (COPD) (cases 2, 3), three patients had syphilis (cases 1, 10, 12), and one patient had no known disease (case 11). Only one patient had a history of tuberculosis (case 5).

### Table 3. Clinical Review of 12 Patients with Frequent Isolation of M. xenopi

| No. | Age/Sex | Symptoms               | X-ray                     | Previous Medical Hx       | No. xen. Is/No. sps. Rec. | Other AFB isolates                  |
|-----|---------|------------------------|---------------------------|---------------------------|---------------------------|------------------------------------|
| 1   | 28Y/M   | F, NS, PC, W          | B/L RNI                   | pneumonia and syphilis    | 2/4                       | none                               |
| 2   | 76Y/M   | stab wound, W         | L-UL cavitary lesion      | PUD, dep, COPD            | 28/30                     | none                               |
| 3   | 65Y/M   | F, NS, PC, W          | R-UL, L-UL ML infiltrates | pneumonia, cecal polyph COPD | 2/4                       | none                               |
| 4   | 41Y/M   | H, NS, PC, SOB, W     | B/L RNI                   | AIDS, PCP, salmonella sepsis Candidiasis, cocaine dependence | 2/13                       | none                               |
| 5   | 39Y/M   | F, C, NS, W NPC, fatigue | intestinal infiltrate B/L HA | AIDS, PCP, HT, Sch, TB  | 3/8                       | M. avium                          |
| 6   | 53Y/M   | W                      | B/L HA                    | AIDS, HT, RF, RT          | 2/2                       | none                               |
| 7   | 47Y/M   | F, NPC, NS, SOB Weight loss | B/L II                   | AIDS, HT, PCP            | 2/7                       | M. avium                          |
| 8   | 33Y/F   | L ear discharge, F, PC, SOB, W | B/L II                   | AIDS, PCP, OE            | 2/2                       | none                               |
| 9   | 30Y/F   | F, PC, SOB, CP Weight loss | B/L II                   | AIDS, PCP, thrush        | 6/10                      | M. avium                          |
| 10  | 28Y/F   | F, NS, PC, W Weight loss | B/L LL pneumonia         | syphilis, pneumonia cocaine dependence | 2/3                       | none                               |
| 11  | 33Y/F   | F, CP, weight loss    | calcified granuloma       | none                      | 1/1                       | none                               |
| 12  | 40Y/F   | F, HA photophobia     | mediastinal adenopathy    | neurosyphilis             | 1/2                       | none                               |

Twelve patients with repeated isolates of M. xenopi were recorded and their charts were reviewed for relevant clinical history. Patient symptoms, on admission, are briefly listed, as are X-ray findings, previous medical history, and the number of M. xenopi isolates cultured from each patient in relation to specimens submitted. F, fever; C, chills; PC, productive cough; NPC, non productive cough; NS, night sweats; W, weakness; SOB, shortness of breath; H, hemoptysis; HA, headache; AIDS, acquired Immune Deficiency Syndrome; CP, chest pain; HT, hypertension; RF, renal failure; RT, renal transplant; Sch, schizophrenia; TB, tuberculosis; COPD, chronic obstructive pulmonary disease; RNI, reticulonodular infiltrates; HA, hilar adenopathy; II, interstitial infiltrate; OE, otitis externa; PCP, pneumocystis carinii pneumonia; B/L, bilateral; PUD, peptic ulcer disease; R, right; L, left; UL, upper lobe; ML, middle lobe; LL, lower lobe; No. xen. Is/No. sps. Rec, Number of M. xenopi isolates/Number of specimens received for AFB (acid fast bacilli) culture.
DISCUSSION

Our results show an increase in the number of *M. xenopi* isolates. At our institution, only 33 isolates of *M. xenopi* were reported during the nine years before 1990 (9). Currently, we report that 3 isolates from 3 patients were found in year 1, 5 isolates from 5 patients in year 2, 21 isolates from 17 patients in year three, 47 isolates from 39 patients in year four, and 57 isolate from 36 patients in year five. Similar observations were also described in Upstate New York (8), New Jersey (4), and Ontario Canada (13).

The clinical relevance of NTM isolates is usually determined by criteria of the American Thoracic Society (ATS) for establishing an NTM disease (14). Since the patients presented in our study had underlying disease(s), it was difficult to determine the clinical relevance of *M. xenopi* isolation. However, this organism was repeatedly isolated from some of our patients. Therefore, we included patients who were deemed to have clinical infection as judged by repeated isolation of the organism (14).

Host factors reportedly associated with *M. xenopi* disease include chronic obstructive pulmonary disease (COPD), pneumoniaosis, extrapulmonary neoplastic disease (15-18), alcohol abuse (19, 20), Pott’s disease (21), arthritis (22-24), and other factors (13, 25-27). It has also been reported as a pathogen in HIV infection and in other immunocompromised states, as both pulmonary and extrapulmonary infections, although its role as a primary versus coexistent infection remains unclear (25, 28-33). Consistent with this literature, our review showed that host factors include AIDS (50%), syphilis (25%), COPD (17%) and not known in one patient (case 11).

Disease caused by *M. xenopi* is usually pulmonary (14, 32) and the presentation can closely mimic that of tuberculosis (1, 3). Symptoms of pulmonary disease caused by *M. xenopi* mainly include: productive cough, weight loss, fever, and to a lesser extent, hemoptysis, pleuritic chest pain, night sweats, and weakness (8, 13, 34). Among the 12 patients presented, 10 were suspected to have a pulmonary infection (cases 1-10). In these patients, the most common findings were weakness (80%), productive or non-productive cough (80%), fever (70%), and night sweats (60%), while fewer patients had shortness of breath (40%), weight loss (20%), chest pain (10%), and hemoptysis (10%).

Radiographically, non-tuberculous mycobacterial infection can mimic tuberculosis (21). It is characterized by multiple thin-walled cavities mostly bilateral, affecting the upper lobes, infrequent hilar retraction due to volume loss, infrequent pleural reaction adjacent to cavitation, and reticulonodular parenchymal infiltrates (36-39). Likewise, our patients with suspected pulmonary infection presented with interstitial infiltrate (50%) reticulonodular infiltrate (20%), bilateral hilar adenopathy (20%), and upper lobe lesions (20%).

*M. xenopi* has recently been isolated from water sources (40, 41) and birds are thought to be a natural host reservoir in some countries (42). However, outbreaks of *M. xenopi* have been associated with colonized hot water sources in private residence and hospitals with the route of infection most likely by the inhalation of aerosols generated during washing or showering (32, 41, 43-46). In our study, most patients presumably acquired the organism outside the hospital since only one patient had a recent prior admission to our hospital. Further epidemiologic studies are necessary to more precisely determine the source and route of infection of these organisms. Although some patients did well on anti-tuberculosis medications, there was no evidence that *M. xenopi* was the cause of the lung damage, rather than the colonization of an already damaged one.

Since *M. xenopi* can cause pulmonary symptoms similar to tuberculosis, and the AFB smear may be positive in some cases, mycobacteriology laboratories should be able to identify and report this organism to physicians in the shortest possible time. This is important so that *M.xenopi* infection can be distinguished from tuberculosis and managed accordingly, in terms of therapy and infection control plans. In our laboratory, the use of HPLC for Mycobacterium identification has substantially reduced the time required for identification of this slow growing organism.

REFERENCES

1. Falkinham JO. Epidemiology of infection by Non Tuberculous Mycobacteria. *Clin. Microbiol. Rev.* 1996; 9: 177-215.
2. Ahkee S, Srinath L, Huang AK, Ramirez JA. Clinical Significance of Mycobacterium other than Tuberculosis Isolated from Respiratory Specimens at University Hospital. *J. Ky. Med. Assoc.* 1995; 93: 53-55.
3. Jacoby HM, Jiva TM, Kaminiski DA, Weymouth LA, Portmore AC. *Mycobacterium xenopi* Infection Masquerading as Pulmonary Tuberculosis in Two Patients Infected With The Human Immunodeficiency Virus. *Clin. Infect. Dis.* 1995; 20: 1399-1401.
4. Marx CE, Fan KE, Morris AJ, Wilson ML, et al. Laboratory and Clinical Evaluation of *Mycobacterium xenopi* Isolates. *Diagn Microbiol Infect. Dis.* 1995; 21: 195-202.
5. Hoffner SE. Pulmonary Infections Caused by Less Frequently Encountered Slow-Growing Environmental Mycobacteria. *Eur. J. Clin. Microbiol. Infect. Dis.* 1994; 13: 937-941.
6. Levy A, Rusu R, Mates A. *Mycobacterium xenopi*: A Potential Human Pathogen. *Isr. J. Med. Sci.* 1992; 28: 772-775.
7. Banks J, Hunter AM, Campbell IA, Jenkins PA, et al. Pulmonary Infection with *M. xenopi*: Review of Treatment and Response. *Thorax* 1984; 39: 376-382.
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8. Jiva TM, Jacoby HM, Weymouth LA, Kaminiski DA, et al. Mycobacterium xenopi: Innocent Bystander or Emerging Pathogen. Clin. Infect. Dis. 1997; 24: 226-232.
9. Shafer RW, Sierra MF. Mycobacterium xenopi, Mycobacterium fortuitum, Mycobacterium kansasii and other nontuberculous Mycobacteria in an Area of Endemicity for AIDS. Clin. Infect. Dis. 1992; 15: 161-162.
10. Butler WR, Thibert L, Kilburn JO. Identification of Mycobacterium avium Complex Strains and Some Similar Species by High Performance Liquid Chromatography. J. Clin. Microb. 1992; 30: 2698-2704.
11. Kent PT, Kubica GP. N-acetyl-L-cysteine-Sodium Hydroxide (NALC-NaOH) Method. In: Public Health Mycobacteriology: A Guide For the level III Laboratory. Atlanta, GA: CDC. 1985; p.36.
12. Butler RW, Cage G, Gross WM, Jost KC, et al. In Standardized Method for HPLC identification of Mycobacteria. Atlanta, GA: CDC. 1996; p.8.
13. Contreras MA, Cheung OT, Sanders DE, Goldstein RS. Pulmonary Infection with Non-tuberculous Mycobacteria. Am. Rev. Respir. Dis. 1988; 137: 149-152.
14. American Thoracic Society. Diagnosis and Treatment of Disease Caused by Non-tuberculous Mycobacteria. Am. J. Respir. Crit. Care Med. 1997; 156: S1-S25.
15. Tellis CJ, Beechler CR, Ohashi DK, Fuller SA. Pulmonary Disease Caused by Mycobacterium Xenopi. Am. Rev. Respir. Dis. 1977; 116: 779-783.
16. Elston HR, Duffy JP. Mycobacterium xenopi and Mycobacteriosis: A Clinical and Bacteriologic Report. Am. Rev. Respir. Dis. 1973; 108: 944-949.
17. Doyle WM, Evander LC, Gruft H. Pulmonary disease caused by Mycobacterium xenopi. Am. Rev. Respir. Dis. 1968; p979-197922.
18. Engbaek HC, Vergmann B, Baess I, Will DW. M. xenopi: A Bacteriological Study of M. xenopi Including Case Reports of Danish Patients. Acta Path. Microbiol. Scand. 1967; 69: 577-594.
19. McDonald PJ, Tomasovic AA, Evans C. Mycobacterium xenopi Pulmonary Infection in Man. Med. J. Aust. 1971; 71: 873.
20. Richter PE, Tomasovic AA, Paxon TG. Pulmonary Disease Related to Mycobacterium xenopi. Med. J. Aust. 1969; 1: 1246-1247.
21. Miller WC, Perkins MD, Richardson WJ, Sexton DJ. Pott’s Disease Caused by Mycobacterium xenopi. Case Report and Review. Clin. Infect. Dis. 1994; 19: 1024-1028.
22. Yuen K, Fam AG, Simor A. Mycobacterium xenopi Arthritis. Journal of Rheumatology. 1998; 25: 1016-1018.
23. Telgdt DS, van der Hoogen FH, Meis JF, Lemmens JA, et al. Arthritis and Spondylodiscitis Caused by Mycobacterium xenopi in A Patient with Systemic Lupus Erythematosus. Br. J. Rheumatol. 1997; 36: 1025-1026.
24. Clark JE, Abinun M, Flood TJ, Cant AJ. Mycobacterium xenopi Osteomyelitis. Pediatr. Infect. Dis. 1997; 16: 1011.
25. Bankier AA, Stauffer F, Lomoschitz F, Brunner C. Mycobacterium xenopi infection of A 50 Year Old Oil Plombage Complicated by Bronchopleural and Pleurocutaneous Fistulas. Journal of Thoracic Imaging. 1999; 14: 307-311.
26. Thomas P, Liu F, Weiser W. Characteristics of Mycobacterium xenopi Disease. Bull. Int. Union. Tuberc. Lung Dis. 1988; 63: 12-13.
27. Smith MJ, Citron KM. Clinical review of Pulmonary Disease Caused by Mycobacterium xenopi. Thorax. 1983; 38: 373-377.
28. Stauffer F, Bankier AA, Strasser G, Kreuzer S, et al. Mycobacteria other than Tuberculosis with an Emphasis on Mycobacterium xenopi in Clinical specimens From AIDS patients at the University of Vienna from 1989-1996. Wiener Klinische Wochenschrift. 1999; 111: 56-58.
29. Bankier AA, Stauffer F, Fleischmann D, Kreuzer S, et al. Radiographic Findings in Patients with Acquired Immunodeficiency Syndrome, Pulmonary infection, and microbiologic Evidence of Mycobacterium xenopi. Journal of Thoracic Imaging. 1998; 13: 282-288.
30. Juffernans NP, Verbon A, Danner SA, Kuijper EJ, et al. Mycobacterium xenopi in HIV-Infected Patients: An Emerging pathogen. AIDS. 1998; 12: 1661-1666.
31. El-Helou P, Rachlis A, Fong I, Walmsley S, et al. Mycobacterium xenopi Infection in Patients with Human Immunodeficiency Virus Infection. Clin. Infect. Dis. 1997; 25: 206-210.
32. Wayne LG, Sramek HA. Agents of Newly Recognized or Infrequently Encountered Mycobacterial Diseases. Clin. Microbiol. Rev. 1992; 5: 1-25.
33. Koizumi JH, Sommers HM. Mycobacterium xenopi and Pulmonary Disease. Am. J. Clin. Path. 1980; 73: 826-830.
34. Costrini AM, Mahler, Gross WM, Hawkins JE, et al. Clinical and Roentgenographic Features of Nosocomial Pulmonary Disease Due to Mycobacterium xenopi. Am. Rev. Respir. Dis. 1981; 123: 104-109.
35. Miller WT. Spectrum of Pulmonary Nontuberculous Mycobacterial Infection. Radiology. 1994; 191: 334-350.
36. Wittram C, Weisbrod GL. Mycobacterium xenopi Pulmonary Infection: Evaluation with CT. Journal of Computer Assisted Tomography. 1998; 22: 225-228.
37. Anderson DH, Grech P, Townsend, RH, Jephcott AE. Pulmonary Lesions due to Opportunistic Mycobacteria. Clin. Radiol. 1975; 26: 461-469.
38. Cook PL, Ridde RW, Simon G. Bacteriologic and radiographic Features of Lung Infection by Opportunistic Mycobacteria: a review. Tubercle. 1971; 52: 232-241.
39. Chapman JS. The Present Status of the Unclassified Mycobacteria. Am. J. Med. 1962; 33: 471-477.
40. Slozarek M, Kubin M, Jaresova, M. Water-Borne Household Infections Due to M. xenopi. Cent. Eur. J. Clin. Microbiol. 1993; 32: 1773-1778.
41. Bullin CH, Tanner EI, Collins CH. Isolation of Mycobacterium xenopi From Water Taps. J. Hyg. (Camb). 1970; 68: 97-100.
42. Wolinsky E. Non-tuberculous Mycobacteria and Associated Diseases. Am. Rev. Respir. Dis. 1979; p119-159.
43. Rahman AFMS, Synclair AL. Mycobacterium xenopi: Pathogen of The Future. Lancer. 1984; 221: 1467.
44. Wright EP, Collins CH, Yates MD. Mycobacterium xenopi and Mycobacterium kansasii in Hospital Water. J. Hosp. Infect. 1985; 6: 175-178.
45. Gross WM, Hawkins JE, Murphy DB. Origin and Significance of Mycobacterium xenopi in Clinical Specimens. Water as A Source of Contamination. Bull. Int. Union. Tuberc. 1976; 51: 267-269.
46. McSwigan DA, Collins CH. The Isolation of M. kansasii and M. xenopi From Water systems. Tubercle. 1974; 55: 291-297.