Clinical and Radiographic Manifestations of Uncommon Pulmonary Nontuberculous Mycobacterial Disease in AIDS Patients*

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Study objective: To determine the clinical and radiographic findings of nontuberculous mycobacteria (NTM) other than *Mycobacterium avium* complex (MAC) and *Mycobacterium kansasii* in AIDS compared with non-AIDS patients.
Design: A retrospective chart review of all patients in whom NTM other than MAC complex and *M kansasii* were isolated between April 1, 1989, and October 31, 1995.
Setting: University-affiliated hospital.
Patients: Fifty-four patients met the criteria for uncommon pulmonary NTM disease: (1) repeated isolation of atypical mycobacterium in colony counts of ≥3 from two or more sputum specimens; *or* isolation of the organism from transbronchial or open lung biopsy specimen with histologic changes suggestive of mycobacterial disease in the absence of other pathogens; *and* (2) either an abnormal chest radiograph, the cause of which had not been attributed to an active infection other than atypical mycobacterial disease; *or* the presence of one or more symptoms indicative of pulmonary disease coupled with exclusion of other illnesses with similar symptoms and signs.
Results: Thirty-five patients were HIV positive. Fever was the only clinical symptom more commonly seen in HIV-infected patients with NTM than non-HIV-infected patients. Sixty-six percent of all patients with AIDS were infected by *Mycobacterium xenopi*. Chest radiographs of AIDS patients showed a tendency for predominance of interstitial infiltrate and rarity of fibronodular disease. No specific radiographic pattern was observed for any particular organism. Adenopathy was not a feature of uncommon pulmonary NTM in AIDS, and it should suggest an alternate diagnosis. In two patients, NTM isolation from respiratory specimens preceded dissemination. Six of 8 AIDS patients treated for pulmonary NTM remained alive at the end of the study compared with only 4 of 15 patients who were not treated for pulmonary NTM ($p<0.05$).
Conclusions: Uncommon NTM isolated from respiratory specimens ought to be considered as serious pathogens in the presence of clinical and radiographic manifestations unexplained by other pathologic processes. Colonization with NTM could precede dissemination. Treatment of uncommon pulmonary NTM disease could possibly confer a survival benefit in AIDS patients.
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Key words: AIDS; outcome; uncommon nontuberculous mycobacterium

Abbreviations: CI=confidence interval; MAC=*Mycobacterium avium* complex; NTM=nontuberculous mycobacteria

Nontuberculous mycobacteria (NTM) are ubiquitous organisms that have been increasingly implicated in pulmonary and nonpulmonary diseases.[1-3] Since the 1950s when the NTM were recognized as potential pathogens, the role of these organisms in the pathogenesis of pulmonary disease has been realized slowly. The insidious and indolent nature of the disease and the lack of well-defined diagnostic criteria have long contributed to the scarcity of knowledge of pulmonary NTM infection. With the spread of the AIDS epidemic, the atypical mycobacterium—*Mycobacterium avium* complex (MAC)—has emerged as one of the frequent opportunistic infections isolated in AIDS patients. Although disseminated disease has been the predominant form of

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presentation, bronchopulmonary involvement has been also well described.[4,5] Similarly, *Mycobacterium kansasii*, a known pathogen in immunocompetent hosts, has been shown to be a serious and potentially lifethreatening pulmonary disease in patients with advanced HIV infection.[6] Experience with pulmonary NTM other than MAC or *M kansasii* is relatively limited. Much of the information has been based on small series or case reports of individual patients with disseminated disease.[7-10] The clinical significance of uncommon pulmonary NTM infections in HIV-seropositive patients has not been clearly defined, and the criteria for treatment based on such isolates remain uncertain.

In this article, we describe the clinical and radiographic features of 35 AIDS patients in whom NTM other than MAC and *M kansasii* were suspected to be pulmonary pathogens. Nineteen non-AIDS patients were included for comparison.

Materials and Methods

Study Design

This study was conducted at the Erie County Medical Center, a 479-bed tertiary care teaching institution, affiliated with the State University of New York at Buffalo. The hospital has the largest tuberculosis clinic in Erie County and the major AIDS treatment center in the region. All mycobacterial isolates from this area are referred to the mycobacteriology laboratory at the Erie County Medical Center for final identification.

All patients with positive cultures for NTM other than MAC and *M kansasii* between April 1, 1989, and October 31, 1995, were identified from the mycobacteriology laboratory records. Information was collected through communication with the primary care physician, chart review, and the death registry for the State of New York. The data consisted of standard demographic information (age, gender, race), social information (smoking history), and detailed medical history that included previous or recent history of purified protein derivative conversion, HIV status, active pulmonary tuberculosis, COPD, bronchiectasis, diabetes mellitus, cystic fibrosis, and cured or uncured malignancy. Clinical data that were available at the time the diagnosis of NTM disease was made were extracted from patients' charts and consisted of fever, productive cough, dyspnea, hemoptysis, night sweats, weight loss, and chest pain. Any symptom reported of <2 weeks' duration was not recorded. This cutoff was selected arbitrarily to avoid reporting fleeting symptoms. Weight loss was defined as fall of >10% of ideal body weight within the previous 6 months. Laboratory studies from hospital admission included the CBC, serum creatinine, arterial blood gases, and blood lymphocyte CD4 count. Patients who were receiving antimycobacterial agents at the time of specimen collection were identified.

Diagnostic Criteria

The diagnosis of AIDS was made using the Centers for Disease Control surveillance criteria.[11] Uncommon NTM disease referred to NTM disease due to mycobacterium other than MAC and *M kansasii*. Uncommon pulmonary NTM disease in AIDS patients was defined as present if the following criteria were met: (1) repeated isolation of atypical mycobacterium in colony counts of ≥3 from two or more sputum specimens; *or* isolation of the organism from transbronchial or open lung biopsy specimen with histologic changes suggestive of mycobacterial disease in the absence of other pathogens; *and* (2) either, an abnormal chest radiograph, the cause of which had not been attributed to an active infection other than atypical mycobacterial disease, *or* the presence of one or more symptoms indicative of pulmonary disease coupled with the exclusion of other illnesses with similar symptoms and signs. NTM disease in HIV-negative patients was established according to the published guidelines of the American Thoracic Society for the diagnosis of atypical mycobacterium.[12] Disseminated NTM referred to the isolation of the NTM from blood, bone marrow, or organs other than the lungs or lymph nodes.[13] For purposes of constructing the survival plot, the diagnosis of uncommon pulmonary NTM disease was made the date of collection of the respiratory specimens that were culture positive for NTM other than MAC and *M kansasii*.

Radiographic Analysis

Chest radiographs were reviewed independently by one pulmonologist and one radiologist blinded to the patient's microbiology results. The chest radiographs were divided into six zones: the right and left upper zones (above the inferior aspect of the fifth rib posteriorly), the right and left middle zones (between the inferior aspect of the fifth and the ninth rib posteriorly), and the right and left lower zones (below the inferior aspect of the ninth rib posteriorly). The pattern and location of parenchymal infiltrates (interstitial, alveolar, reticulonodular, or mixed) and/or cavities were noted. In addition, the presence of adenopathy (hilar, mediastinal, or paratracheal) and pneumothorax was recorded if present. The size and location of pleural effusions or fibrosis were also reported when present. Localized disease was defined as the involvement of one radiographic zone on the chest radiograph. Involvement of three or more radiographic zones indicated diffuse disease. When available, radiographs taken at the time of specimen collection were compared with previous radiographs obtained at least 4 weeks earlier. A complete resolution was defined as disappearance of the radiographic abnormalities. A partial resolution referred to at least 30% resolution in the radiographic abnormalities.

Data Analysis

Descriptive statistics for continuous variables were expressed as mean±1 SE. Differences in mean values were assessed using Student's *t* test. Univariate analysis was performed using the χ^2 and Fisher's Exact Tests. Survival analysis of treated and untreated AIDS patients with pulmonary NTM disease was performed using the Kaplan-Meier life table method and compared by the Mantel-Cox (log-rank) tests.[14] All tests were two tailed, and statistical significance was determined at the 5% level.

Results

Patient Population

One hundred sixty-eight patients were identified from the mycobacteriologic records. Fifty-four patients met the inclusion criteria for uncommon NTM disease. Fifty-one of the 54 patients included in the study were seen in the emergency department or

ambulatory care clinic and were admitted to the hospital for respiratory complaints or abnormal chest radiographs suspicious for active pulmonary tuberculosis. During their hospital stay, all of the 51 patients on whom acid-fast bacilli sputum smears were requested were placed in respiratory isolation in compliance with an isolation policy implemented at the hospital to minimize the risk of nosocomial transmission of tuberculosis. The remaining three patients had their conditions diagnosed in the outpatient tuberculosis clinic. Thirty-five patients were HIV infected and carried the AIDS diagnosis according to the Centers for Disease Control surveillance criteria.[11] Risk factors for HIV infection included homosexuality (n=15), parenteral drug abuse (n=8), and blood transfusion (n=1). In 12 patients, there was no documentation of the mode of transmission. Nineteen patients did not have risk factors for HIV, 12 of whom had no serologic evidence of HIV infection. Most of the patients were male smokers or ex-smokers. Table 1 shows the patient characteristics included in the study.

Associated Conditions

AIDS: In HIV-infected patients, 11 of 35 (31%) patients had history of *Pneumocystis carinii* pneumonia; however, none of these patients had *P carinii* isolated at the time of specimen collection. One patient had a history of treated pulmonary tuberculosis, and one had a history of disseminated cryptococcosis. COPD was reported in one patient. Twenty-one of 35 patients (60%) had no identifiable underlying pulmonary disorder.

Non-AIDS: In non-AIDS patients, preexisting lung disease was noted in 14 of 19 patients (74%). The most common associated disorder was previous mycobacterial tuberculous disease reported in 6 of 19 patients (32%). All had received chemotherapy for >6 months with at least three antituberculous agents (isoniazid, rifampin, and pyrazinamide or ethambutol) during the first 2 months. The length of time between the diagnosis of active tuberculosis and NTM disease averaged 11.2 years. Bronchiectasis, gastroesophageal disorders, and chronic obstructive lung disease were identified in 7 of 19 patients (37%). Bronchogenic carcinoma (adenocarcinoma) was detected in one patient. The remaining five patients (26%) had no identifiable disorder. A positive reaction to purified protein derivative was noted in 11 of 19 patients (58%).

Clinical Disease

Fever was the only clinical manifestation that was significantly reported more frequently in patients with AIDS and NTM disease than non-AIDS patients ($p<0.001$) (Table 2). Cough was the next most common symptom, followed by dyspnea and weight loss. Hemoptysis, albeit rarely described, was identified in two AIDS patients (6%), one had *Mycobacterium xenopi* identified from the sputum cultures, the other had disseminated *Mycobacterium fortuitum*. Both patients showed lower lobe involvement on the chest radiograph. In non-AIDS patients, hemoptysis was seen in four patients with predominantly upper lobe disease. Three patients had *M xenopi*, and one had *Mycobacterium marinum*. There was no statistical difference in frequency of weight loss or hemoptysis between both groups.

Table 1—*Patient Characteristics*

	AIDS (n=35)	Non-AIDS (n=19)	Total (n=54)
Age, yr*	35.4±1.2	58.7±3.9	
Gender, No. (%)			
Male	27 (77)	14 (74)	41 (76)
Female	8 (23)	5 (26)	13 (24)
Race, No. (%)			
White	10 (29)	9 (47)	19 (35)
Black	17 (49)	6 (32)	23 (43)
Hispanic	8 (22)	3 (16)	11 (20)
Other	0	1 (5)	1 (2)
Cigarette use, No. (%)			
Active smoker	19 (54)	4 (21)	23 (43)
Ex-smoker	8 (23)	7 (37)	15 (28)
Never smoked	6 (17)	5 (26)	11 (20)
Unknown	2 (6)	0	2 (9)

*$p<0.001$, HIV positive compared with HIV negative.

Table 2—*Comparison of Clinical Symptoms and Laboratory Data of AIDS and Non-AIDS Patients With Uncommon Pulmonary NTM*

Clinical Symptoms	AIDS (n=35)	Non-AIDS (n=19)	p Value
Cough			
Present	23	16	0.21
Absent	12	3	
Fever			
Present	26	2	<0.001*
Absent	9	17	
Weight loss			
Present	19	5	0.08
Absent	16	14	
Hemoptysis			
Present	2		
Absent	32		
Laboratory studies			
WBC count, cells/mm^3	5.2±0.4	8.6±0.8	0.001*
Hemoglobin, g/dL	10.4±0.3	12.8±0.4	<0.001*
Creatinine, mg/dL	1.4±0.1	0.9±0.1	0.02*
Arterial Po_2, mm Hg	71.7±2.9	65.2±2.5	0.1

*Indicates statistical significance at the 95% level.

Patients had been generally symptomatic for months to years before the diagnosis had been made (range, 6 weeks to 8 years). However, AIDS patients were more likely to have their conditions diagnosed at an earlier time than their non-HIV-infected counterparts (mean duration of symptoms: 3.8 months in AIDS patients, 2.4 years in non-AIDS patients). Total WBC count and hemoglobin level were significantly lower, and serum creatinine concentration was significantly higher in HIV-infected patients than non-HIV-infected patients (Table 2). Although AIDS patients had higher PaO_2 at the time of specimen collection, the difference between HIV-infected and non-HIV-infected patients was not statistically significant ($p=0.1$).

Acid-fast smears were positive in 11 of 35 AIDS patients (31%) compared with 5 of the 19 non-HIV-infected patients (26%) ($p=0.7$). The site of isolation of NTM in the AIDS group is listed in Table 3. Nine of 35 AIDS patients (26%) had disseminated disease, 6 (67%) of whom had positive acid-fast smears on presentation. Of interest, two patients had positive sputum culture for *M xenopi* reported prior to disseminated disease. The time interval between isolation of NTM from sputum and disseminated disease was 343 and 265 days, respectively. In contrast, none of the non-HIV-infected patients in this study had extrapulmonary NTM disease.

Radiographic Findings

AIDS: The chest radiographic findings in uncommon pulmonary NTM were noncharacteristic of any organism isolated. The most common patterns seen on radiograph were interstitial (37%) and mixed disease (26%). Cavitary disease was described only in one patient (2%). A reticulonodular pattern was rarely seen, and occurred in 2 of 35 patients (6%). Adenopathy was not observed in the cases reviewed. Normal radiographic findings were described in 5 of 35 patients (14%) (Table 4). Two of the five patients with normal radiographs underwent CT of the chest for evaluation of persistent fever. Basilar interstitial infiltrates were described in the lower lobes of both patients. Culture of the transbronchial biopsy specimens and BAL obtained from the described areas yielded the same mycobacterium isolated from the sputum culture.

The disease was localized radiographically in 10 of 35 patients (29%), and it was seen predominantly in the lower lobes (7 of 10). Two zones of involvement were noted in 11 of 35 patients (31%), while 9 patients had diffuse disease on initial chest radiograph, 6 of whom had *M xenopi*, 2 who had *M fortuitum*, and one who had *Mycobacterium malmoense* as the etiologic agents.

Non-AIDS: The most frequent radiographic patterns were mixed (interstitial/alveolar) (32%) and reticulonodular (21%). A cavitary lesion was noted in 2 of 19 patients (11%). Two patients had pleural effusions, and one patient had a normal chest radiograph (Table 4). Localized disease occurred in 10 of 19 patients (53%) with the majority (6 of 10) reported in the upper zones of the chest radiographs. In those patients with previous upper lobe pulmonary tuberculosis, the new infiltrates were distributed in and around the area of previous disease. Six patients (32%) had two zones of involvement; 2 of these zones were contiguous. Two patients (11%) presented with diffuse disease and both had *M xenopi* identified in their sputa.

Table 3—*CD4 Count and Site of NTM Isolation in AIDS Patients*

	Mean CD4	Blood	Renal	Skin	Respiratory
M fortuitum (n=4)	39.7	1	0	1	4
M gordonae (n=1)	3.0	0	0	0	1
M chelonae (n=3)	25.3	0	0	0	3
M malmoense (n=3)	13.0	2	0		3
M terrae (n=1)	70.0	0	0	0	1
M xenopi (n=23)	38.7	4	1	0	23

Treatment and Outcome

AIDS: Figure 1 reveals the outcome of AIDS patients with NTM disease. All AIDS patients with disseminated NTM were treated with various combinations of antimycobacterial agents (two or more drugs). Two of nine patients were still alive at the end of the study, and one moved out of the state and was unavailable for follow-up. The median survival of the six deceased patients from the date of diagnosis to death was 155 days (95% confidence interval [CI], 88 to 221 days). The primary cause of death as listed on the death certificates was sepsis in three patients, *P carinii* pneumonia in two patients, and Pseudomonas pneumonia in one. Autopsy results were not available.

Eight of the 26 AIDS patients with nondisseminated uncommon pulmonary NTM were treated; 6 of them were still alive at the termination of the study. In contrast, only 4 of the 18 untreated patients survived. Despite a loss of three patients for follow up, the difference was statistically significant (Fisher's Exact Test $p=0.04$). A survival analysis curve for treated and untreated patients is shown in Figure 2 (Cox-Mantel log-rank test $p<0.03$). Two patients who received treatment had complete resolution of the radiographic abnormalities. Three others had partial improvement, and in one case, there was no

Table 4—*Chest Radiographic Findings for AIDS and Non-AIDS Patients (n=35) With NTM Pulmonary Disease*

	Normal	Localized Disease	Diffuse Disease	Interstitial Alveolar Nodular	Mixed	Cavitary	Pleural
AIDS							
Total (n=35)	5	10	9	20	9	1	4
M xenopi (n=23)	4	4	6	13	5	1	3
Non-AIDS							
Total (n=19)	1	10	2	10	6	2	2
Rapid growers (n=13)	0	3	0	7	4	2	0

significant difference from the previous radiograph. The median survival of the 11 untreated AIDS patients with nondisseminated uncommon pulmonary NTM who died during the study period was 340 days (95% CI, 226 to 454 days). None of the deaths were attributed directly to NTM disease.

Non-AIDS: Two of the 19 non-HIV-infected patients died during the study. One had a complicated acute myocardial infarction, and the other died of septicemia. Eleven patients received a course of treatment directed against the atypical mycobacterium. Six of the 11 patients (55%) had partial radiographic improvement on follow-up, and 3 had no significant change. No follow-up chest radiographs could be found on the remaining two patients.

Discussion

To our knowledge, this study is the first comprehensive description of the clinical and radiographic features of pulmonary NTM disease other than MAC or *M kansasii* in AIDS patients. Previous reports of NTM disease in the AIDS population were limited to anecdotal cases of disseminated NTM disease. The recognition of the pathogenecity of these microorganisms was limited by the difficulty in associating clinical disease to positive cultures, frequent coexistent pathogens, and lack of established diagnostic guidelines. Thus, inclusion criteria were crucial to the proceeding of the study and were based on previously advanced standards for the diagnosis of atypical mycobacterium in immunocompetent hosts.[12,15] Thus, only patients with very high suspicion of pulmonary NTM disease were included. Most of the patients excluded had NTM isolated from one sputum sample or had coexisting disease, particularly *P carinii* or MAC.

M xenopi was the most common mycobacterial species cultured from AIDS respiratory specimens. *M xenopi* infection was originally thought to be an infrequent and relatively benign disease. Recent reviews have indicated a rise in its prevalence among immunocompetent hosts[16] and the AIDS population.[17] Shafer and Sierra[17] reviewed 86 culture specimens positive for NTM other then *M avium*, and

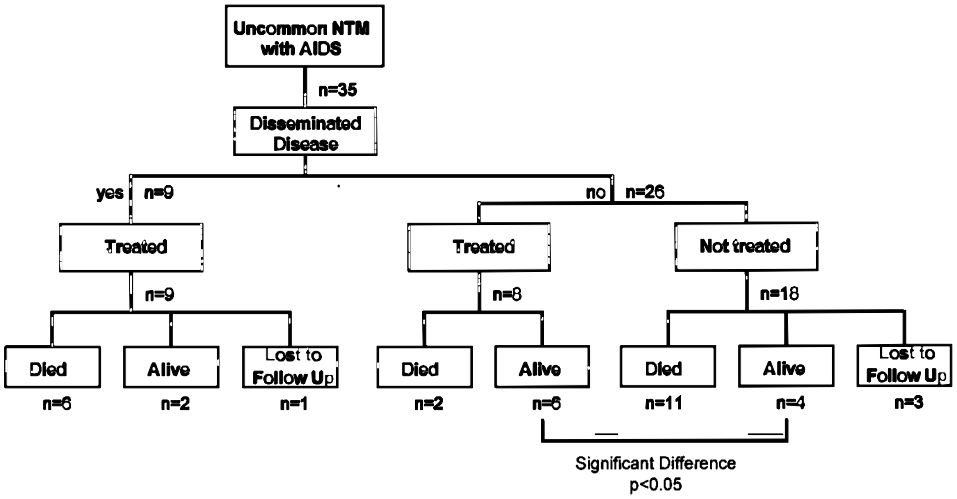

FIGURE 1. Outcome of patients with uncommon NTM disease in AIDS patients.

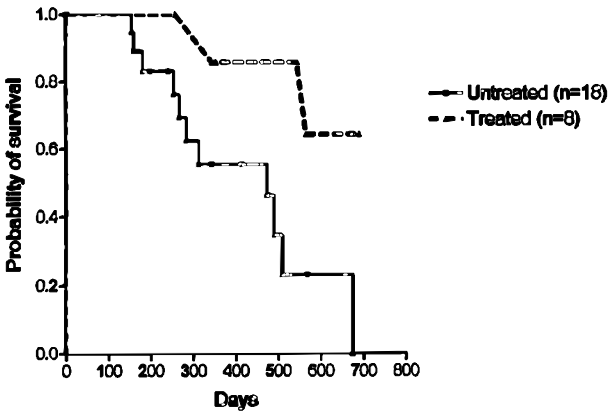

FIGURE 2. Kaplan-Meier survival curves for treated and untreated nondisseminated pulmonary NTM.

Mycobacterium gordonae at King's County Hospital in Brooklyn, NY, and identified *M xenopi* in 33 specimens. Those patients in whom *M xenopi* was isolated had a higher likelihood to be HIV seropositive than those from whom other species were isolated. Contaminated hospital water supplies have been implicated in several outbreaks,[2] but no specific source for infection could be traced in our study.

The presenting clinical manifestations of patients with uncommon pulmonary NTM disease in this series were in accordance with what is reported in the literature.[8,18] In a review of the clinical features of HIV-infected patients with *M kansasii* pulmonary infection, Levine and Chaisson[6] reported the presence of fever in 17 of 19 patients. Cough and dyspnea were noted in 17 and 14 patients, respectively. Similarly, Barber et al[8] described fever, dyspnea, and cough in 4, 3, and 3 of 5 patients, respectively, with suspected pulmonary disease secondary to *M gordonae*. Still, it is difficult to attribute these symptoms solely to pulmonary NTM infection, as some of these clinical manifestations have been reported in patients with AIDS without documented infection.[19]

The radiographic manifestations of uncommon pulmonary NTM disease were not specific for any organism isolated. Nevertheless, the radiographic patterns seen in this study were consistent with the literature reviews[15,20] of uncommon pulmonary NTM disease. Cavitary disease was rare even in immunocompetent hosts with uncommon pulmonary NTM, and when seen, it is often a consequence of underlying disease. In AIDS patients, there was a tendency for an increase in interstitial pattern and a rarity of fibronodular disease. These findings are thought to be secondary to atypical formation of epithelioid granulomas in severely immunocompromised patients.[21,22] Adenopathy was not observed in our series. To our knowledge, there is only one report that described hilar adenopathy in two of five AIDS patients with *M gordonae*.[8] However, the authors acknowledged that standard diagnostic criteria were not met in these patients. Until a larger series is published, it would be advisable to investigate adenopathy for a concurrent infection or underlying neoplastic process.

Pulmonary NTM infections with normal chest radiographs, although unusual, have occurred in 14% (95% CI, 4.8 to 30.3) of our study population and have been reported in 21% (95% CI, 11.3 to 52.2) of patients with MAC.[18] In these cases, CT of chest could be helpful in guiding diagnostic evaluation of NTM isolates.

The isolation of NTM from sputum cultures of two patients who developed disseminated disease with the same species has two important clinical implications. First, isolation of these organisms from pulmonary specimens of AIDS patients ought to be investigated for possible underlying disease rather than simple contamination. Second, early treatment of NTM pulmonary disease should be considered seriously to prevent subsequent dissemination. Schraufnagel et al[23] described three types of relation between NTM and the lungs in immunocompetent hosts. The first is colonization of the respiratory tract, which was defined as isolation of mycobacteria without skin test conversion and with no clinical or radiographic signs of infection; the second is subclinical infection where there is conversion of skin test, but no clinical evidence of disease; and last, clinical disease with symptoms and signs of infection. If these relations hold true in immunocompromised hosts, a spectrum ranging from colonization to dissemination could be delineated. The propensity of whether a patient with pulmonary NTM colonization will develop disseminated disease is probably determined by two factors: (1) the severity of the patient's underlying immunodeficiency, and (2) the affinity of NTM to the respiratory tract. Zaugg et al[7] reported that the ratio of respiratory to nonrespiratory cases of infection varies with NTM species. For MAC, the ratio is 2.4, while for *M xenopi* it is 25.0. This was consistent with our findings as we described two patients who developed disseminated disease with *M xenopi* following isolation of the organism from their respiratory specimen.

The survival data presented in this study indicate that treatment of pulmonary NTM disease in AIDS patients could confer a survival benefit compared with those who were not treated for pulmonary NTM. The improved survival was in-

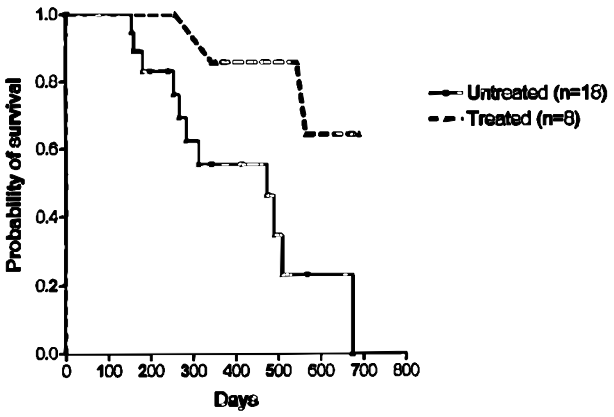

FIGURE 2. Kaplan-Meier survival curves for treated and untreated nondisseminated pulmonary NTM.

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The survival data presented in this study indicate that treatment of pulmonary NTM disease in AIDS patients could confer a survival benefit compared with those who were not treated for pulmonary NTM. The improved survival was in-

dependent of CD4 count. It is well documented in the literature that patients with disseminated MAC and *Mycobacterium genavense* who are treated survive longer than those who are not.[24,25] Pechere et al[25] reported improved survival of 40 patients with disseminated *M genavense* who received antimycobacterial drugs for at least 30 days compared with 12 who did not (median survival, 210 and 81 days, respectively [p=0.02]). Age, gender, and CD4 count were not statistically different between the two groups. This study is the first (to our knowledge) to suggest a potential survival benefit from treatment of patients with nondisseminated pulmonary NTM in AIDS patients. It is difficult to know, however, whether the improved outcome is secondary to treatment of pulmonary NTM or secondary to prevention of infection with other mycobacterium species as MAC or *Mycobacterium tuberculosis* or both. It should be stressed that these findings are based on a retrospective analysis. The treatment group was not randomized, and thus the possibility of a bias toward initiating treatment in patients with fewer coexisting complications could not be excluded. Moreover, the absence of a single effective regimen and the frequent drug toxic reactions encountered during treatment precluded any specific recommendation regarding therapy.

In conclusion, we have reported our data on a significant number of AIDS patients with pulmonary NTM that carry important clinical implications. First, NTM other than MAC or *M kansasii* isolated from respiratory specimens of AIDS patients should not be attributed to environmental contaminant in the presence of clinical and radiographic manifestations unexplained by other pathologic processes. Second, early treatment of pulmonary NTM should be considered not only for symptomatic improvement, but also to prevent dissemination, and possibly improve survival. A prospective multicenter cooperative study is needed to elucidate these issues further.

ADDENDUM

Since the submission of this manuscript, the American Thoracic Society has issued revised criteria for the diagnosis of NTM.[26] These criteria were developed to fit best for MAC, *Mycobacterium abscessus*, and *M kansasii*. As the authors themselves state, the applicability of the definition for other NTM is uncertain. The operational definitions of NTM lung used in our article encompass only the uncommon NTM disease as an investigational tool and differs in purpose and intent from the August 1997 American Thoracic Society definition.

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