Nontuberculous Mycobacterial Disease
Following Hot Tub Exposure

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Nontuberculous mycobacteria (NTM) have been recognized as an important
cause of disease in immunocompromised hosts. Pulmonary disease
cased by NTM is increasingly recognized in previously healthy persons.
Investigation of pulmonary disease affecting a family of five identified an
indoor hot tub as the source of NTM-related disease.

Nontuberculous mycobacteria (NTM) are an important
cause of disease in the United States, with the number of
NTM isolates exceeding those of Mycobacterium tuberculosis
(1). Pulmonary disease, the most commonly reported local-
ized manifestation of NTM, is often associated with the
M. avium complex (MAC) (2). Other NTM species, such as
M. kansasii, M. fortuitum, M. xenopi, and M. abscessus, have
also been associated with pulmonary disease (2,3). Although
NTM-associated pulmonary disease has been described pri-
marily among immunocompromised persons (4,5), it is being
recognized with increasing frequency among those without
predisposing conditions (2,6,7).

Unlike MTB, NTM are not known to be transmitted per-
to person. Most NTM have been isolated from water or
soil (8-14). Species such as MAC are thermophilic (12), resis-
tant to chemical germicides (14), and readily aerosolized
(13). For several NTM species, environmental sources have
been linked epidemiologically to cases of disease (15-20). In
1991, Burns investigated an outbreak of respiratory tract
colonization in which epidemiologic and pulsed-field gel elec-
trophoresis (PFGE) findings implicated a contaminated
showerhead as the source of M. fortuitum (21). Subse-
quently, von Reyn used PFGE to link MAC infection in five
AIDS patients to hot water sources in two hospitals (22).

Recently, Embil et al. (23) described five persons who
became ill with pulmonary disease following exposure to hot
tubs. MAC was isolated from all five patients and the two
tubs. When MAC isolates were examined by multilocus
enzyme electrophoresis (MEE), however, the hot tub and
patient isolates had different MEE patterns. Kahan et al.
(24) reported one patient diagnosed with MAC disease asso-
ciated with a hot tub. In this case, the organisms isolated
from the patient and the tub were identical by MEE.

The Study

In October 1998, the Boulder County Health Depart-
ment and the Tuberculosis Program, Colorado Department
of Public Health and Environment, began an investigation
into an apparent cluster of tuberculosis cases among a previ-
ously healthy family of five.

Case 1: This patient, a 46-year-old woman, was in excel-
ient health until early June, when she noted the onset of
shortness of breath and a dry cough. A chest radiograph at
the time was consistent with early right lower lobe bron-
chial pneumonia. The patient was treated over the subse-
quent weeks with a series of antibiotics, including
amoxicillin and azithromycin, without improvement. During
early July, she had fever as high as 104°F approximately
every 4 days, accompanied by night sweats and preceded by
chills. A chest radiograph showed increased markings in the
right lower lobe medially with associated peribronchial
thickening and some faint air bronchograms consistent with
an early bronchial pneumonia. She was begun on a course of
tetracycline and prednisone (50 mg four times a day for 3
days, decreased to 20 mg four times a day for 11 days). Dur-
ing this time the patient traveled to Disneyland and while
away felt much improved. Her symptoms recurred with the
cessation of steroids and return home, however, and by the
end of August, her shortness of breath, night sweats, and
malaise had worsened, and she had an 18-pound weight loss.

Before she became ill, the patient had exercised regu-
larly. In late August, her shortness of breath worsened so
that she was unable to walk across a room, and she visited
the hospital. A chest radiograph showed increased intersti-
tial markings in both lungs. A computed tomographic (CT)
scan of the chest showed a diffuse increase in pulmonary
interstitial markings, with a ground-glass background. On
September 10 the patient underwent fiberoptic bronchos-
copy. A right lower lobe biopsy showed an occasional non-
caseating granuloma consistent with sarcoidosis. Stains for
acid-fast bacteria (AFB) and fungi were negative.

A chest radiograph obtained September 10 following
bronchoscopy showed a fine reticular interstitial pattern
Cases 3, 4, and 5: The 14-, 12-, and 9-year-old sons of Patients 1 and 2 became ill in mid-September with influ-

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1 and 4 had the greatest exposure to the hot tub aerosols. In retrospect, they described a clear relationship between hot tub exposure and worsening of symptoms, i.e., recurrence of night sweats, chills, and fever.

Following identification of MAC and M. fortuitum from clinical specimens (Table) and further consultation, Patients 1 and 4 were begun on a regimen of rifampin, ethambutol, amikacin, clarithromycin, ciprofloxacin, and prednisone. Patients 2, 3, and 5 were treated with clarithromycin and ciprofloxacin. After 6 months, pulmonary function tests for Patients 1 and 4 had improved (Table), signs and symptoms had resolved, and chest radiographs were normal for all family members.

The results of sputum evaluation on smear and culture for AFB are summarized (Table). Patient 4 was smear and culture positive for AFB, but negative on probe for MTB or MAC. The organism was subsequently identified as M. fortuitum.

Patient and water isolates were initially identified as MAC and typed by MEE, with identical enzyme profiles (25). Restriction fragment-length polymorphism (RFLP) analysis with an insertion sequence specific for M. avium (IS 1245) (26) confirmed that all isolates were the identical strain of M. avium (Figure). Isolation of M. fortuitum from this hot tub has been described (27).

**Conclusions**

NTM organisms isolated from the hot tub are likely responsible for this family's illness for the following reasons: exposure to the hot tub was temporally related to onset of symptoms; MAC was isolated from the lung biopsy and sputum of one patient and the sputum of two others, as well as from the hot tub; and MAC isolates from patient specimens and the hot tub were identical by RFLP. In addition, M. fortuitum was isolated from both the hot tub and a fourth hot tub-exposed person.

The source of the MAC and M. fortuitum is unclear. Our inability to isolate either organism from samples from the tanker truck used to supply water for the hot tub does not rule this out as a source. NTM have been isolated from municipal water supplies in the past (22). Alternatively, the users may have introduced the organisms, as the children often used the tub without showering first.

Proliferation of these organisms in a hot tub is not surprising, as both MAC and M. fortuitum are thermophilic (12). Moreover, at temperatures >84°F, chlorine loses much of its efficacy as a disinfectant (15).

Controversy exists as to whether persons with pulmonary disease secondary to NTM are experiencing a hypersensitivity reaction to the organisms or symptoms secondary to true infection (28,29). Murphy concludes that in the presence of dyspnea, nodular infiltrates seen on CT, response to steroids, and absence of predisposing factors such as chronic lung disease, a patient with MAC-related lung disease has hypersensitivity pneumonitis. Pathologic findings, including palisaded and multinucleated histiocytes and granulomatous inflammation, however, suggest infection (28). In a recent case presentation, symptoms and radiographic findings in a patient from whose lung tissue MAC was cultured are consistent with both the diagnoses of hypersensitivity pneumonitis and atypical mycobacterial infection, a conclusion substantiated by pathologic findings (29). In cases evaluated at National Jewish Medical and Research Center, most patients required treatment with both steroids and antituberculous medications (30). This experience suggests that NTM disease represents a spectrum of disease with components of both hypersensitivity pneumonitis and infection.

Our cases had characteristics of both hypersensitivity pneumonitis and true infection. The short interval between hot tub use and exacerbation of symptoms and the patchy ground-glass appearance of the lungs, with centrilobular nodules on CT, suggest hypersensitivity pneumonitis (31). The granulomas seen on pathologic examination and the response to treatment with antituberculous medications, however, suggest true infection. The temporary improvement in Patient 1’s condition after she received prednisone may represent either appropriate treatment of hypersensitivity pneumonitis or a decrease in granulomatous inflammation in the bronchioles, secondary to infection (28).

Little data exist to explain the mechanism of disease caused by NTM in healthy persons. Exposure to sufficiently large and repeated inocula of the organism in droplets of readily respirable size appears to be sufficient to overwhelm normal host defenses.

Hot tubs should be maintained according to manufacturers’ recommendations, which include both frequent water changes and adequate use of disinfectants. In addition, placing a hot tub in an enclosed environment should be strongly discouraged. Patients with atypical pneumonia should be questioned about similar illnesses among family member and others who have had similar exposures, including exposure to a hot tub. As hot tubs become increasingly popular (pers. comm., John J. Cergol, Jr.), hot tub-related illness associated with NTM may become an emerging infectious disease challenge.

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