

Mycobacterium avium complex Infection among Spa Workers in New Mexico

Two cases of lab-confirmed *Mycobacterium avium* complex infections (MAC) were reported to the New Mexico Department of Health in July 2009. The symptoms, exposures, and presence of MAC were indicative of hot tub lung, a hypersensitivity pneumonitis (HP) – like granulomatous lung disease with non-tuberculous mycobacteria (NTM), that can occur from exposure to hot water aerosols from spas, therapy pools, showers, and indoor swimming pools.^{1,2,3,4} Person-to-person transmission does not occur.⁵ MAC, a type of NTM, consists of two or more mycobacterial species, *M. avium* and *M. intracellulare*. The two cases were employed at a spa establishment with several outdoor tubs. Because of the suspected work-related nature of the illnesses, the cases were referred for investigation to the New Mexico Occupational Health Surveillance Program (NMOHSP), Epidemiology and Response Division (ERD) in February 2010.

Methods

The NMOHSP worked with the two regulatory entities having oversight of the commercial establishment, the NM Occupational Health and Safety Bureau (NMOHSB) and the NM Swimming Pool Program, both of the NM Environment Department.

The exposure assessment focused primarily on work processes at the spa although surveys of workers included questions about home exposure, recent travel, and second jobs. Confirmed cases were those employees who had tested positive for *M. avium* from February 2009 to February 2010, while probable cases were those who only had respiratory symptoms indicative of HP within the same time period.

The NMOHSP reviewed the medical records and interviewed the two MAC-positive patients. Interviews were also conducted with other current and former employees. Based on interview responses, jobs were grouped into categories based on three exposure levels - 1) The *Tub cleaner* category consisted of workers

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who cleaned and maintained tubs including the cleaning of pumps, filters, and checking water chemistry; 2) *Tub worker*, a lower exposure category, consisted of non-maintenance workers who had frequent contact with tubs, including checking water temperature, cleaning the areas around spas, covering tubs at closing and adding shock treatment, when needed; 3) and *Non-exposed* employees had no contact with tubs during performance of job duties. Symptom history questions included dry cough, cough with phlegm, wheezing, shortness of breath, fever, chills, aches, tiredness, and weight loss. The number of symptoms for each employee was calculated and it was determined if the mean number of symptoms for employees varied between exposure categories.

An occupational health and safety inspection was carried out by NMOHSB. The Swimming Pool Program conducted inspections of each tub over a period of two weeks. Additionally, the NMOHSP conducted an informal walk-through assessment to observe tasks that could potentially expose workers. Water samples and swabs of biofilms from tubs and filters were collected for microbial analysis conducted at the Centers for Disease Control and Prevention (CDC) Environmental Microbiology Laboratory.

Results

The first case-patient sought initial medical treatment in August 2009 with signs and symptoms of cough, hemoptysis, and dyspnea that began in February 2009. He had a 10 mm ppd and a chest x-ray which showed diffuse interstitial disease. The patient's sputum grew *Mycobacterium avium-intracellulare* (MAI – also referred to as MAC) in the lab. Symptoms worsened and he was hospitalized in September 2009. A high-resolution CT scan showed scattered areas of ground-

glass infiltration within all lobes, consistent with pulmonary infection. In December 2009, he saw a pulmonologist who suspected that his symptoms were linked to the workplace and encouraged the patient to report this condition to his employer. Sputum cultures from February 2010 were negative and the patient has recovered.

A second tub maintenance worker was seen in May 2009 at the local public health office with worsening cough and respiratory symptoms. Sputum obtained June 2009 grew MAC in culture. He was hospitalized in July. Discharge medications were not filled because the patient could not afford them. The worker was still symptomatic, but had been accommodated in another job position working part-time only, at the time of interview in February 2010. He has since recovered. Medical evaluation of other current and former employees was not undertaken and no additional confirmed cases were found during interviews conducted as part of this investigation.

Employee interviews. NMDOH interviewed 56 of the establishment's employees (67%) plus one former employee. All but one of the employees with tub exposure duties was interviewed. Interviewed workers included 28 females and 29 males with a mean age of 37 years. Interviewed workers included 13 tub cleaners, 23 tub workers and 21 non-exposed employees. The length of employment ranged from less than one year to 23 years (mean 4.7 years). Employees worked an average of 33.4 hours per week ranging from 12 to 55 hours. Twenty employees reported working at other jobs but there was no association between symptoms and outside employment (data not shown). Thirty-five of the employees interviewed denied having any of the listed symptoms. Employees with symptoms reported an average of two symptoms and one employee reported eight. The most common symptom was cough with phlegm (13), followed by dry cough (12), wheeze (9), tiredness (8), chills (7), shortness of breath (6), weight loss (5), chest tightness/ fever (4), and aches (3). The mean number of symptoms was associated with exposure category (p -value = 0.008) (Figure).

NMDOH observations. The focus was on the "filter deck", a small, poorly ventilated shed where filters were cleaned. After soaking in trisodium phosphate, filters were sprayed with a chemical filter cleaner and were then hosed clean which created a considerable

amount of aerosolized water within the shed. The worker performing this task was wearing a half-mask respirator during observation, but inconsistent wearing of personal protective equipment (PPE) was reported during worker interviews. Filter cleaning can take up to two to three hours daily. It was also revealed that the filter deck had been enclosed within the past year and was previously open to the air.

OSHA inspection. The NMOHSB Compliance Section conducted an inspection and several violations were noted including violations for improper PPE assessment, storage, and sanitation; chemical and air contaminant exposures; and lack of employee safety and PPE use training.

Pool inspection. Inspections noted some questionable work practices including collecting water samples for routine testing at the plumbing ports inside the equipment rooms, and pressure washing cartridge filters, then commingling and rotating them from one spa to another at random. Water clarity in most tubs was excellent but minor water quality violations were noted. Most of these related to the spas' operation in excess of their upper limit of 75 ppm of hydrogen peroxide disinfectant. Four spas were not having their flow rate monitored and bather loads in the community tubs were neither posted nor enforced. Water chemistry logs were not being completed for some tubs and water testing was not being conducted every two hours as required by the permit as issued.

Laboratory assessment. All water samples collected during February 2010 had a substantial burden of rapid and slow-growing mycobacteria. Thirteen of the environmental isolates were selected to represent a variety of sampling locations with which to compare human isolates. High pressure liquid chromatography (HPLC) testing and polymerase restriction analysis (PRA) identified the two patient isolates and the 13 environmental isolates as *M. avium* complex, while 16S rRNA sequencing identified the isolates as *M. avium*. Pulsed-field gel electrophoresis (PFGE) of the tested isolates revealed diverse band patterns. Two environmental isolates were closely related to one patient's isolate. The second patient isolate did not appear to be closely related to any of the other tested environmental isolates. However, given the tremendous quantity of *M. avium* recovered from the samples, the presence of a

source related to the second patient's isolate could not be ruled out.

Discussion

MAC is ubiquitous; it can be found in water, soil, food, and it concentrates in biofilms. The hydrophobic nature of the two organisms that comprise MAC (*M. avium* and *M. intracellulare*), and high mycolic acid content of their cell walls make MAC highly resistant to disinfectants used in pools and spas, including chlorine and ozone, as well as to UV disinfection methods.^{7,8,9} Hydrogen peroxide can stimulate the growth of biofilms which harbor *M. avium* by inducing an oxidative stress response.¹⁰ Laboratory simulations of aerosolization processes with *M. intracellulare* indicate a pathway for human infection.⁷

Although most of the cases of MAC found in the literature have been associated with home spa use, occupational cases at public recreational water facilities (pools and spas) have been noted. In 2002, Rickman noted that there had not been any reported cases of hot tub lung occurring with outdoor spa exposure.¹⁰ The findings in this report could be the first cases reported in association with outdoor tubs. However, because the filter deck location where exposure was thought to have taken place was enclosed, exposures should be considered to have taken place indoors.

The NMDOH was in agreement with the violations cited and recommendations made by NMOHSB and NMED Swimming Pool Program. The NMDOH also recommended that the establishment:

1. Conduct an independent industrial hygiene assessment of the filter deck and adopt ventilation recommendations.
2. Assure that respiratory protection is worn when filters are being washed and while power washing tubs to protect against aerosolized biofilms.
3. Prevent, or at a minimum, control the growth of biofilms in all parts of the spa circulation system.
4. Discontinue use of wooden tubs where biofilms may accumulate.
5. Discontinue the use of hydrogen peroxide as a disinfectant.
6. Use halogen disinfection
7. Use an EPA-approved tuberculocide to treat surfaces coming into contact with spa water where biofilms tend to accumulate.

Additional recommendations for health care providers include:

8. For aerosol-exposed patients/workers diagnosed with atypical pneumonia, submit biological specimens for laboratory testing for MAC.
9. Report all potential occupational cases of MAC to the NM DOH as per New Mexico Administrative Code 7.4.3.12.
10. Remove MAC positive workers from work environments where further exposure could occur.

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Figure. Mean MAC-Associated Symptoms Reported by Work Exposure Group in Spa Investigation, New Mexico, 2010

