HOT TUB LUNG: AN INTRIGUING DIFFUSE PARENCHYMAL LUNG DISEASE

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SUMMARY

In pulmonary medicine, identical pathogenesis due to varied etiological agents can present with indistinguishable clinical presentation, and produce similar laboratory and radiological changes. The importance of eliciting detailed occupational and social history from patients cannot be stressed enough when dealing with patients suffering from diffuse parenchymal lung diseases.

Hot Tub Lung(HTL) is a perplexing pulmonary disease attributed to the Mycobacterium Avium-intracellulare Complex (MAC). MAC is a ubiquitous atypical mycobacterium present in moist environment, and is not considered pathogenic, without the predisposing conditions like immunosuppression. However, HTL is a unique disease seen in healthy individuals following the exposure to contaminated hot water in spas. The less virulent MAC will, in healthy individual will elicit mild granulomatous inflammation particularly around the peribronchiolar region, which leads to the development of diffuse parenchymal lung. We report a case of HTL to increase the awareness of this rare and enigmatic disease among medical professionals, and to reiterate the importance of eliciting social and occupational details in clinical practice.

Keywords: Hot Tube Lung, Atypical Mycobacterium, Mycobacterium Avium-intracellulare Complex (MAC), Hypersensitivity Pneumonitis

CASE PRESENTATION

A young 37 year old white female from southern United States presented to pulmonary medicine for an evaluation of recent onset dyspnea and cough. Her exertional dyspnea had started one month previous, and had progressed significantly in the past week to the point that she had to gasp for air to perform daily activities. Her dry cough also started one month previous and worsened in the past week too. In the past month, she felt feverish but did not record her temperature. She did endorse a 20 pound unintentional weight loss during this time. She had been smoking a pack of cigarettes for the past 30 years, and stopped smoking two weeks earlier as her sickness progressed. She denied any recent change in the amount of smoking or change in the brand of cigarettes. She had no reported history of recreational drug use as well as no recent travel or sick contact. She had separated from her husband in the past year, and her current residence was a tractor trailer. She made her living by taking care of a friend, who is recently disabled due to stroke.On presentation to the hospital, she was febrile with a temperature of 100 F, tachypneic with a respiratory rate in the 30s, tachycardic with a heart rate in 110s, and, also, hypoxic thus requiring 4L of intra-nasal oxygen to maintain the saturation of more than 90%. Her respiratory system examination showed bilateral end-inspiratory crackles distributed more in the lower thoracic regions. She had no wheezes or bronchial breath sounds. The remaining clinical examination was unremarkable.

Figure 1 Chest x ray showed bilateral diffuse nodular opacities in both lungs

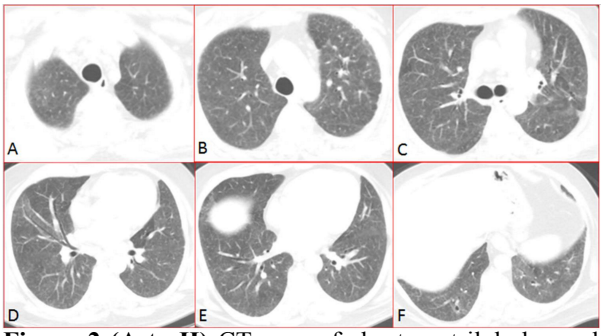

Figure 2 (A to H) CT scan of chest centrilobular nodules with bronchiolar wall thickening distributed both in the central and peripheral regions of the upper and lower lobes

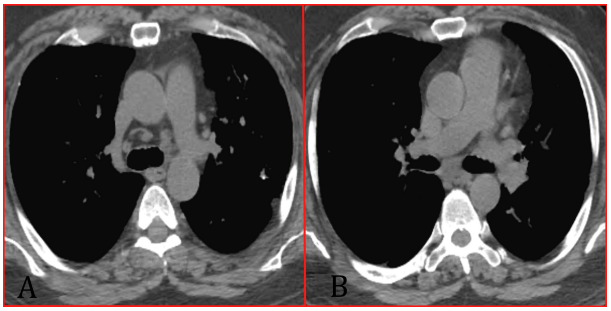

Figure 3. Nonspecific mediastinal lymphadenopathy

Leukocyte count was normal, and procalcitonin was negative. Extensive investigations, including: sputum cultures, blood cultures, respiratory viral panel, serum beta glucan, histoplasmosis urine antigen, Serum galactomannan, sputum AFB smear, and Interferon Gamma Release Assay (TB gold) came back as normal. Bronchoscopy with Bronchio-alveolar lavage (BAL) from the right middle lobe, blind transbronchial biopsy from the right middle lobe, and Endobronchial ultrasound (EBUS) needle aspiration of the mediastinal lymph node were done as a part of the evaluation for diffuse parenchymal lung disease.

Gram stain, Acid Fast Bacilli (AFB) Stain, and fungal stains of BAL fluid were also negative. Lung biopsy showed granulomatous inflammation. EBUS needle aspiration of subcarinal lymph node also showed similar findings. Based on these clinical-radiological and pathological findings hypersensitive pneumonitis (HP) was considered. She did report that she cleaned her trailer two months before she fell sick, but denied any mold infestation of her trailer.

She also denied any exposure to any undue organic or inorganic dust in the recent time. But, the nature of diffuse involvement of both lungs, and its failure to resolve with cessation of exposure made a case against acute HP. Other differential diagnosis considered were viral infections and nodular sarcoidosis and Non-tubercular Mycobacterium (NTM).

The patient was treated with empirical antibiotics in the hospital with some improvement in symptoms, but still remained hypoxic. She was discharged home with a supplemental home oxygen therapy and plans to follow up in the pulmonary clinic. In the interim, she was admitted again to an outside hospital for worsening dyspnea. She underwent extensive investigation at the outside hospital again, including a bronchoscopy and lung biopsy, which once again showed lymphocytic inflammation with granulomas. She was treated with steroids and antibiotics without any significant clinical improvement.

Meanwhile, a AFB culture of BAL sample performed two months prior at our hospital came back positive for moderate *Mycobacterium avium-intracellulare*. She was immediately called to the pulmonary stat clinic, and further history was obtained. At this time, she revealed that for the past three months she has been helping her friend with recent stroke and paralysis to get physical therapy in the hot water tub, called hydrotherapy. They had bought the hot tub at a local flea market, and the seller also provided them with the cleaning solution, which they used once a week. Both of them spent nearly three hours every day in the hot tub for the hydrotherapy. As our patient is sick and unable to provide her friend help, her friend had sold the hot tub and despite multiple attempts the new owner of the hot tub could not be reached. Our patient's friend had multiple medical problems and had similar amount exposure to the hot tub, but, interestingly, she did not develop any respiratory problems. On the contrary, she claimed that the hydrotherapy helped her strength.

Our patient clearly developed respiratory symptoms after exposure to the hot water tub. Chest x ray and CT scan showed diffuse nodular lung disease; lung biopsy showed diffuse granulomatous inflammation and Mycobacterium avium was isolated from the bronchoscopic lung specimen. Based on these findings, our patient was diagnosed with Hot tub lung. As she was symptomatic, she was started on Rifampicin, Azithromycin and Ethambutol given three times a week, as per American thoracic society guidelines for treatment of MAC.

She continued to have a dry cough despite being on antimycobacterial treatment regime, therefore, daily prednisone (20 mg/day) was added to her regime.

After two months of treatment, her cough and chest pain subsided and the dyspnea improved. Chest x ray showed resolution and CT scan showed improvement. Her general wellbeing also improved, and she gained six pounds. She is currently being followed-up in pulmonary clinic.

DISCUSSION

The hot tub lung is a unique granulomatous lung disease caused by MAC contaminating the man made hot water reservoirs like hot water tubs and Spas. In 1977, Dr. Kahana, LM described the first related case of HTL in a young immunocompetent female who developed dyspnea, fever, and weight loss after exposure to a hot tub[1]. Diffuse alveolitis with noncaseating granuloma was seen on open lung biopsy. MAC was isolated from biopsy, and a similar strain was also isolated from the water specimen of the hot tub that she used.[1] In the following four decades, approximately 70 cases of HTL have been described in the English literature, mostly as case reports or case series with modest cases. The largest case series of HTL was reported from Mayo clinic that included 21 patients .[2]

Non-tubercular Mycobacterium (NTM) is ubiquitous bacteria with the highest concentrations found in soil, natural water reservoirs, and engineered water distribution systems. Of more than 150 different strains isolated to date, MAC is implicated predominantly in human disease. These mycobacteria have an outer lipid rich hydrophobic layer that helps them to adhere to the surfaces, and prevents them from getting washed away by running water. This layer also protects them from the effect of commonly used water disinfectants like chlorine and ozone. This inherent characteristic of MAC offers survival advantage over other microbes, and enable them to from colonies in artificial water systems.[3,4] MAC is a thermophilic organism, and, unlike other microbes, is able to thrive in temperature up to 52 degree centigrade.[5] In a study, involving nine hot water tubs and nine hot water therapy facilities at a major metropolitan city in the United States, MAC was cultured from 13 out of the 18(72%) hot water sites.

Cultures taken from outside air samples of these facilities were negative ruling out the possibility of air contamination of the water.[6] Similar findings were echoed in another study by Angenent LT.[7] The MAC will latch on to the air bubbles trapped in the water, and then will be ejected into the air when these bubbles burst open upon reaching the surface of water leading to bioaerosolization of MAC in the atmosphere. This bubble-burst, jet-drop mechanism can lead to more than a 1,000-fold increase in the number of viable mycobacterial cells per ml of water droplets ejected, and the cells are readily inhaled by the healthy people using the hot water tubs and spas.[8,9,10] Unlike other disease caused by MAC, HTL is described in healthy individuals without any evidence of preexisting conditions. There is no human to human transmission reported. The recreational use of hot water tubs and spas has increased worldwide. In the United States alone 400,000 spas are being sold annually.[9] The use of hot water therapy as a form of physical therapy has increased and is being used for various medical conditions. Due to rising recreational and medical use of hot water, we expect an increase of disease burden for HTL. The few case reports published in literature tends to under represent the disease prevalence represent the tip of the iceberg.

As NTM is not a reportable disease, the exact incidence of HTL is not known. Most cases are reported from United States, Europe, and Japan. A literature search with the keywords “Hot Tub Lung.” and a cross referencing of article references, returned 70 cases in the English literature.[1,2,8,11-16] The articles mostly describe healthy middle aged individuals, with the mean age of 58.8 years (range 30 to 69). No sex predilection was noted (Males 51% and females 49%).

The mean duration of symptoms before accurate diagnosis was 3.6 months with a range of one to 12 months. Only one third of the reported cases were the current smokers, thus suggesting no correlation with smoking. Comprehensive information about HTL is lacking due to inadequate details in the reported cases reports. The salient features of all the described cases are summarized in Table 1.

Dyspnea was the most common symptom seen in the patients followed by cough and fever. Half of the patients had crackles on examination, and half were hypoxic at rest. Chest x rays showed abnormality in 80% of cases with diffuse nodule or interstitial opacities in most cases. CT scan is more sensitive compared to chest x ray and showed abnormality in 100% of reported cases. Ground glass changes in seen in 65% of cases and nodule were seen in 53% if cases(Table1). Pulmonary function tests revealed obstruction in one third of the cases.

Transbronchial biopsy was able to establish diagnosis in 75% of the cases. Biopsy showed granuloma in 92% of the cases. One third of patients received Antimycobacte-

rial drugs alone and 16% of patients received steroids alone.

The specific dose and duration of steroids is not reported accurately in literature, and, hence, the optimal regime of steroid therapy is not known. If antimycobacteral treatment is considered, then the American Thoracic Society (ATS) recommends treatment with three drug Azithromycin/Clarithromycin, Ethambutol, and Rifampin for 12 to 18 months. While 23% of patients received both treatments, 20% of patients were not given any specific treatment except abstinence from source.

Table 1 Summary of salient features of all the described cases

	Number	Prevalence
Exposure history		
• **Indoor hot tub/Shower**	48 / 70	68%
• **Outdoor spas**	09 / 70	12%
• **Unknown**	13 / 70	18%
Symptoms		
• **Dyspnea**	67 / 70	95%
• **Cough**	58 / 70	82%
• **Fever**	37 / 70	52%
• **Weight loss.**	16 / 70	22%
Clinical examination		
• **Crackles**	20 / 44	45%
• **Wheeze**	12 / 40	30%
• **Hypoxia**	28 / 55	50%
Radiological changes		
• **Chest x ray abnormality**		
➢ **Abnormal**	49/61	80%
○ **Diffuse interstitial or nodular opacity.**	43/61	70%
○ **Focal or any abnormality.**	06/61	09%
	58/58	100%
• **CT scan**	38/58	65%
➢ **Abnormal**	31/58	53%
○ **Ground Glass density**		
○ **Nodules.**		
Pulmonary function tests		
• **Obstruction.**	13 / 38	34%
• **Restriction**	07 / 38	18%
• **Diffusion defect.**	05 / 38	13%
Microbiology		
• **Sputum for AFB**	24 / 43	70%
• **Bronchial wash for AFB**	18 / 26	69%
• **Lung biopsy for AFB.**	14 / 44	31%
Diagnosis based on biopsy		
• **Bronchoscopic lung biopsy**	25 / 33	75%
• **Open lung biopsy**	15 / 15	100%
• **Not specified.**	10	
Pathology showing Granuloma	46 / 51	92%
Treatment		
• **Antitubercular treatment only**	21 / 68	30%
• **Steroids only**	11 / 68	16%
• **Both**	16 / 68	23%
• **None**	20 / 68	29%
Response to treatment		
• **Complete**	38 / 63	60%
• **Partial**	25 / 63	39%

Regardless of the type of treatment regime used, clinical response was seen in all patients, and 60% of the patients showed complete resolution. No death due to HTL has been reported to date.

Whether HTL is a true infection or a hypersensitivity reaction due to the MAC is still being debated. The isolation of MAC from clinical specimens and the presence of granuloma with palisading and multinucleated histiocytic in tissue samples of HTL patients supports the hypothesis that it is a true infection. On the other hand, the clinical presentation along with the radiological and pathological findings are similar to hypersensitivity pneumonitis, in addition the spontaneous resolution with or without steroids argues in favor of HTL being a hypersensitivity reaction due to MAC .[17]

However, unlike in classic HP, the granulomas seen in HTL are larger, well-formed, and protrude into the luminal wall. This pathology accounts for the increased yield of transbronchial biopsy in HTL compared to others diffuse lung diseases. Also, the BAL in HTL shows an increased CD4/CD8 ratio suggesting against classic HP, and spirometry shows an obstructive pattern which is not seen in HP.[17] Based on these ambivalent features, some authors argue that HTL is a distinct disease by itself and called it Granulomatous bronchiolitis with organizing pneumonia.[18]

Even though MAC could not be isolated from the water source in our case, our patient developed respiratory symptoms following the use of a hot tub and, showed typical clinical, radiological, and pathological findings consistent with HTL. These characteristic features along with the isolation of MAC from lung biopsy lead to confident diagnosis of hot tub lung. Our patient was previously healthy, and unlikely acquired isolated MAC infection from other atmospheric causes. Our patient, moreover, showed dramatic improvement with treatment. Our case illustrates the importance of a thorough social and occupation history to aid in accurately diagnosing a rare disease.

REFERENCES

1. Kahana LM, Kay JM, Yakrus MA, Waserman S. Mycobacterium avium complex infection in an immunocompetent young adult related to hot tub exposure. *Chest*. 1997 Jan;111(1):242-5.
2. Hanak V, Kalra S, Aksamit TR, Hartman TE, Tazelaar HD, Ryu JH. Hot tub lung: presenting features and clinical course of 21 patients. *Respir Med*. 2006;100(4):610–615.

3. Falkinham JO III. Surrounded by mycobacteria: nontuberculous mycobacteria in the human environment. *J Appl Microbiol*. 2009 Aug;107(2):356-67.
4. Taylor RH, Falkinham JO III, Norton CD, LeChevallier MW. Chlorine, chloramine, chlorine dioxide, and ozone susceptibility of Mycobacterium avium. *Appl Environ Microbiol*. 2000 apr;66(4):1702-5.
5. Torvinen E, Lehtola MJ, Martikainen PJ, Miettinen IT. Survival of Mycobacterium avium in drinking water biofilms as affected by water flow velocity, availability of phosphorus, and temperature. *Appl Environ Microbiol*. 2007 Oct;73(19):6201-7.
6. Glazer CS, Martyny JW, Lee B, Sanchez TL, Sells TM, Newman LS, Murphy J, Heifets L, Rose CS. Nontuberculous mycobacteria in aerosol droplets and bulk water samples from therapy pools and hot tubs. *J Occup Environ Hyg*. 2007 Nov;4(11):831-40.
7. Angenent LT, Kelley ST, St Amand A, Pace NR, Hernandez MT. Molecular identification of potential pathogens in water and air of a hospital therapy pool. *Proc Natl Acad Sci U S A*. 2005 Mar;102(13):4860-5.
8. Verma G, Jamieson F, Chedore P, Hwang D, Boerner S, Geddie WR, Chapman KR, Marras TK. Hot tub lung mimicking classic acute and chronic hypersensitivity pneumonitis: two case reports. *Can Respir J*. 2007 Sep;14(6):354-6.
9. Bruce C. Parker , Mary Ann Ford , Howard Gruft , Joseph O. Falkinham III. Epidemiology of Infection by Nontuberculous Mycobacteria. IV. Preferential Aerosolization of Mycobacterium intracellulare from Natural Waters. *Am Rev Respir Dis*. 1983 Oct;128(4):652-6.
10. Wendt SL, George KL, Parker BC, Gruft H, Falkinham JO III. Epidemiology of infection by nontuberculous Mycobacteria. III. Isolation of potentially pathogenic mycobacteria from aerosols. *Am Rev Respir Dis*. 1980 Aug;122(2):259-63.
11. Sood A, Sreedhar R, Kulkarni P, Nawoor AR. Hypersensitivity pneumonitis-like granulomatous lung disease with nontuberculous mycobacteria from exposure to hot water aerosols. *Environ Health Perspect*. 2007 Feb;115(2):262-6..
12. Hankwitz PE, Cervia JS, Thomas CF, Fink JN, Marras T, Tomic R. Nontuberculous mycobacterial hypersensitivity pneumonitis related to a home shower: treatment and secondary prevention. *BMJ Case Rep*. 2011 Jul 28;2011.
13. Daito H, Kikuchi T, Sakakibara T, Gomi K, Damayanti T, Zaini J, Tode N, Kanehira M, Koyama S, Fujimura S, Ebina M, Ishii KJ, Akira S, Takai T, Watanabe A, Nukiwa T. Mycobacterial hypersensitivity pneumonitis requires TLR9-MyD88 in lung CD11b+ CD11c+ cells. *Eur Respir J*. 2011 Sep;38(3):688-70.
14. Van der Zanden RJ, Magis-Escurra C, de Lange WC, Hoefsloot W, Boeree MJ, van Ingen J, van Soolingen D. Hypersensitivity pneumonitis caused by Mycobacterium avium subsp. hominissuis in a hot tub, as proven by IS1245 RFLP and rep-PCR typing. *Int J Mycobacteriol*. 2012 Sep;1(3):152-4.
15. Fjällbrant H, Akerstrom M, Svensson E, Andersson E. Hot tub lung: an occupational hazard. *Eur Respir Rev*. 2013 Mar;22(127):88-90.
16. Minomo S, Tachibana K, Tsuyuguchi K, Akira M, Kitaichi M, Suzuki K. A Unique Case of Hot Tub Lung Worsening during the Winter. *Internal Medicine*. 2015;54(5):491-5.
17. Marras TK, Wallace RJ, Koth LL, Stulbarg MS, Cowl CT, Daley CL. Hypersensitivity pneumonitis reaction to Mycobacterium avium in household water. *Chest*. 2005 Feb 1;127(2):664-71.

☞✘✎ Agarwal R, Nath A. Hot-tub lung: hypersensitivity to Mycobacterium avium but not hypersensitivity pneumonitis. *Respir Med*. 2006 Aug;100(8):1478.✪