Hot Tub–Associated Necrotizing Pneumonia due to *Pseudomonas aeruginosa*

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We describe a case of severe necrotizing pneumonia due to community-acquired *Pseudomonas aeruginosa*. Cultures of fluid obtained from the filter of the patient's hot tub grew the same *P. aeruginosa* strain as that grown from culture of the patient's sputum. Centers for Disease Control and Prevention guidelines should be strictly followed for hot tub maintenance to prevent *P. aeruginosa* overgrowth: the range of free chlorine levels in the water should be kept at 1–3 mg/L, and the pH should be kept at 7.2–7.8.

Pseudomonas aeruginosa is a common cause of nosocomial respiratory tract, urinary tract, and bloodstream infections but remains a rare cause of community-acquired infection despite its environmental ubiquity. Herein we report a case of severe necrotizing pneumonia due to community-acquired *P. aeruginosa.*

Case report. A 40-year-old man with a history of tobacco use presented to the emergency room after experiencing several days of fevers, chills, and a cough producing blood and rust-colored sputum. Physical examination revealed a temperature of 37.3°C and tachypnea (respiratory rate, 24 breaths/min). Chest examination revealed decreased breath sounds in the upper lung fields bilaterally that were especially notable at the right apex. There were no rales noted, and there was no evidence of egophony or increased tactile fremitus. The findings of the physical examination were otherwise unremarkable. Laboratory abnormalities included leukocytosis (WBC count, 17,900 cells/μL) with a left shift (83% neutrophils), a platelet count of 623,000 cells/μL, and a serum sodium level of 127 m*M*. Chest radiographs revealed a right upper-lobe cavitary lesion with left apical scarring (figure 1), and a subsequent chest CT scan revealed bullous emphysema and consolidation with multiple cystic lesions in the right upper and middle lobes consistent with necrotizing pneumonia. There were no radiographic findings to imply bronchiectasis.

The patient was admitted to the hospital and placed in an airborne isolation room because of concerns he was infected with *Mycobacterium tuberculosis.* He was empirically treated with ampicillin-sulbactam to include coverage for aspiration pneumonia. Staining of sputum samples for an acid-fast bacillus was negative 3 times, and the result of HIV serologic testing was negative. The initial Gram stain of an expectorated sputum sample revealed >25 polymorphonuclear cells per low-power field and <10 epithelial cells per low-power field with numerous nonsporulating gram-negative rods. On the third day of hospitalization, results of sputum culture performed by the microbiology laboratory confirmed the predominant growth of *P. aeruginosa,* with a lesser growth of *Escherichia coli.* Both organisms were sensitive to ciprofloxacin, ceftazidime, and antipseudomonal penicillins, and, although the *P. aeruginosa* isolate was intermediately resistant to gentamicin, it was sensitive to tobramycin. On the basis of these results, the patient's antimicrobial regimen was changed to ticarcillin-clavulanate and ciprofloxacin.

Additional questioning revealed that the patient owned a hot tub and that he had been using it almost daily for the past several weeks. Furthermore, the patient reported drinking alcoholic beverages while in the hot tub and remembered choking on water from the hot tub. He had not received any antimicrobials during the past year and had last been hospitalized when he was a child. He denied having any skin rash or ear pain suggestive of folliculitis or otitis externa.

The patient improved clinically and was discharged home 12 days after admission receiving oral ciprofloxacin therapy. The patient completed a 6-week total course of antibiotics, and an outpatient follow-up visit 1 month after discharge revealed that the patient was healthy. A chest radiograph obtained 6 weeks after discharge revealed right apical scarring of the lung but otherwise complete resolution of parenchymal infiltrates. The patient has since remained healthy more than a year after his admission to the hospital.

The patient's family brought us the hot tub filter because they were concerned that others would become ill. Cultures of fluid from the filter were positive for a *P. aeruginosa* species with the same antimicrobial susceptibility as that of the species grown from culture of the patient's sputum, and restriction

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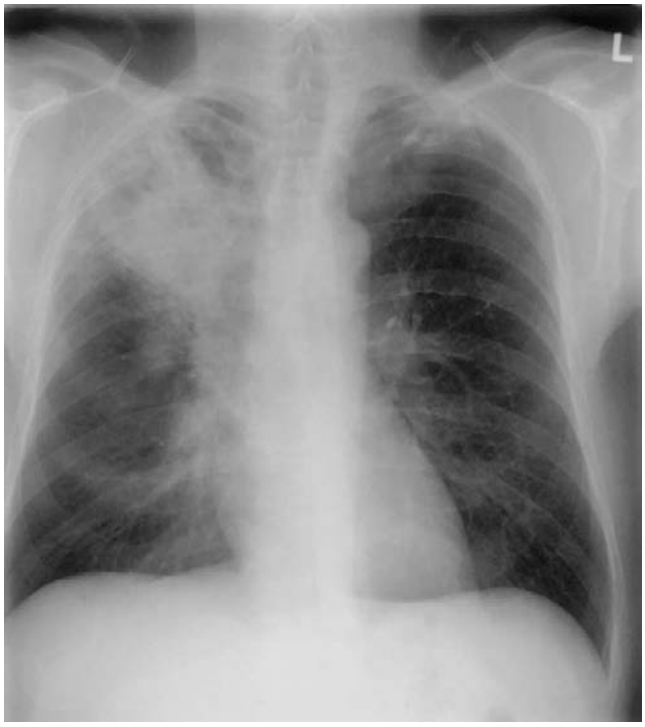

Figure 1. Chest radiograph of the patient at admission to the hospital, revealing a right apical cavitary lesion and left upper-lobe scarring.

fragment–length polymorphism analysis of both the patient's sputum isolate and the hot tub filter isolate was subsequently performed to determine whether they were the same strain. *P. aeruginosa* strains were classified as epidemiologically distinct if a difference of >3 bands was observed [1]. PFGE results demonstrated the presence of 2 distinct *P. aeruginosa* strains in the hot tub water (figure 2, *lanes 2* and *3*), one of which *(lane 3)* has a PFGE pattern identical to that of the *P. aeruginosa* strain isolated from the patient's sputum *(lanes 4–6)*.

Discussion. *P. aeruginosa* is an aerobic gram-negative bacterium that can be isolated from a broad spectrum of sources in the environment, including water, soil, plants, and animals (including humans). It has minimal nutritional requirements, which allow it to multiply even in distilled water. This characteristic explains why *P. aeruginosa* can be isolated from such varied environmental sources as respiratory equipment, cleaning solutions, disinfectants, sinks, loofah sponges, swimming pools, hydrotherapy tanks, whirlpools, hot tubs, and contact-lens solution [2].

P. aeruginosa is rarely isolated from healthy persons, although it can sometimes be cultured from moist areas of the body, such as the axilla, perineum, and the intestinal tract, where it is considered a saprophyte. *P. aeruginosa* is more commonly isolated from the sputum of patients with underlying immunosuppression, such as HIV infection [3], and chronic lung disease, such as bronchiectasis and cystic fibrosis [2].

A few types of community-acquired pseudomonal infections, ranging from minor to serious, have been well described in the literature, including green nail syndrome, toe-web infection, hot tub-associated folliculitis, whirlpool-associated urinary tract infection, otitis externa, pedal osteomyelitis after puncture wounds, and right-side endocarditis in injection drug users [2]. In contrast, community-acquired pneumonia due to *P. aeruginosa* is rare.

Community-acquired *P. aeruginosa* pneumonia in patients without characteristic risk factors has been the subject of only a few case reports published since the 1970s [4–14]. Although some of these cases were attributable to an identifiable source, such as a home humidifier [9] or a home whirlpool spa [8], most cases had no identifiable environmental source of infection [4–7, 10–14]. Our case adds to this small list of com-

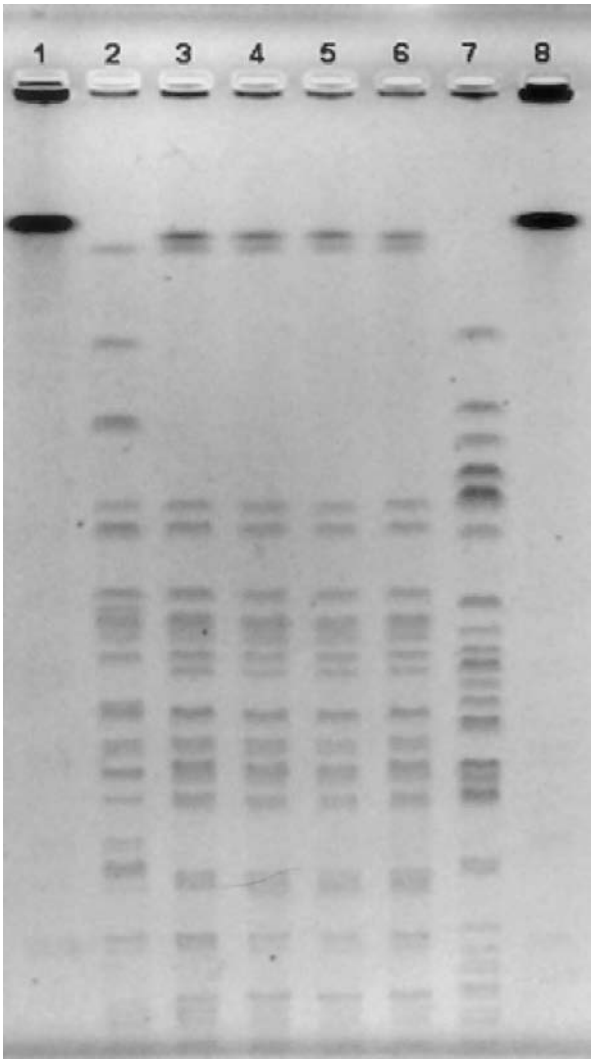

Figure 2. PFGE patterns of *Pseudomonas aeruginosa* isolates: *Lanes 2 and 3,* isolates from the patient's hot tub filter; *lanes 4–6,* isolates from the patient's sputum; *lanes 1 and 8,* λ ladder; *lane 7,* control strain of *P. aeruginosa.*

munity-acquired cases of *P. aeruginosa* pneumonia and is, we believe, the first in which molecular subtyping techniques were used to definitively confirm that a patient's infection derived from an environmental source.

By use of molecular subtyping techniques, we were able to show conclusively that our patient had acquired the *P. aeruginosa* strain that caused his infection from his hot tub. Several factors put the patient at risk for pneumonia, most notably alcoholism and underlying structural lung disease. One recent prospective trial reported that *P. aeruginosa* was recovered from 5% of patients presenting with severe community-acquired pneumonia, and that alcoholism was an independent risk factor for severe pneumonia [15].

Review of the CT scan performed for our patient at admission to the hospital confirmed the presence of underlying bullous emphysema, although there was no evidence of bronchiectasis in any of the images. Although the latter form of structural lung disease has clearly been associated with a risk for colonization or infection with *P. aeruginosa,* we are not aware of literature demonstrating a similar association with emphysema or chronic bronchitis.

Studies performed in the 1980s, amid rapidly increasing reports of whirlpool-associated folliculitis, documented the heavy growth of *P. aeruginosa* in health spa and personal-use hot tubs [16]. On the basis of these reports, the Centers for Disease Control and Prevention published guidelines that specifically recommended that free chlorine levels in the water of public hot tubs be kept at 1–3 mg/L and the pH be kept at 7.2–7.8 to prevent *P. aeruginosa* overgrowth [17].

Most studies of whirlpool-associated folliculitis have shown inadequate free chlorine levels (<1.0 mg/L) in the water that was the source of infection. Free chlorine levels dissipate rapidly in the warm temperatures (>40°C) and turbulent waters of hot tubs, and it has been shown that an elevated water pH (>7.6) is associated with a reduced antibacterial effect of halogens [18]. Studies suggest that *P. aeruginosa* can multiply to levels of 10^4 to 10^6 organisms/mL if the free chlorine level is allowed to drop to <1 mg/L or if the pH is allowed to rise to >7.8 for even as short a time as 24 h [18]. Therefore, it is necessary to monitor these levels on a frequent basis, in order to make the adjustments necessary to maintain the appropriate level of disinfection, and to change the water regularly, especially after heavy use.

Despite the severity of *P. aeruginosa* pneumonia, empirical therapy for community-acquired infections cannot be recommended because of its rarity. However, this case demonstrates that recognition of potential environmental exposures is important for early diagnosis of and therapy for pneumonia of unusual etiology.

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