Pulmonary Pneumatocele in a Pneumonia Patient Infected with Extended-Spectrum \( \beta \)-Lactamase Producing \textit{Proteus mirabilis}  

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Pulmonary pneumatoceles are air-filled thin-walled spaces within the lung and are rare in adult cases of pneumonia. We report the case of a 74-year-old male who was admitted with a cough and sputum production. He had been treated with oral dexamethasone since a brain tumorectomy 6 months prior. Contrast-enhanced computed tomography (CT) of the chest revealed a large pneumatocele in the right middle lobe and peripheral pneumonic consolidation. Bronchoalveolar lavage was performed; cultures identified extended-spectrum \( \beta \)-lactamase (ESBL) producing \textit{Proteus mirabilis}. A 4-week course of intravenous ertapenem was administered, and the pneumatocele with pneumonia resolved on follow-up chest CT. To the best of our knowledge, this is the first reported case of pulmonary pneumatocele caused by ESBL-producing \textit{P. mirabilis} associated with pneumonia.

Keywords: Pneumonia; \textit{Proteus mirabilis}; Beta-Lactamase

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Introduction

Pulmonary pneumatoceles are thin-walled gas-filled cavitary lesions of the lung parenchyma\(^1\), and are common in infants and young children with pneumonia, but unusual in adults\(^2\). Most often, pneumatoceles develop as complications of acute pneumonia, commonly caused by \textit{Staphylococcus aureus}\(^3\). Pneumatoceles are also caused by other organisms such as gram-negative bacilli (especially \textit{pseudomonas}), but reports of pneumatoceles caused by \textit{Proteus mirabilis} are few\(^4,5\).

\textit{P. mirabilis} is often associated with contamination and colonization, but it only occasionally associated with severe infections\(^6\). Antimicrobial resistance has been reported increasingly for \textit{P. mirabilis}, and increased resistance of this species to \( \beta \)-lactams, aminoglycosides, and quinolones has become of great concern\(^6,7\).

We here describe a case of pulmonary pneumatocele caused by \textit{P. mirabilis} in a patient with pneumonia; the organism produced an extended-spectrum \( \beta \)-lactamase (ESBL).

Case Report

A 74-year-old male was admitted with a 2-week history of cough and sputum production. He exhibited low-grade fever and general weakness. His medical history included a brain tumor; tumorectomy of the right frontal cortex and basal ganglia had been performed, followed by concurrent chemora-
Six months prior to the tumorectomy, he received oral dexamethasone (3 mg/day) prescribed by another hospital. Recently, he had become bedridden and state reported irregular aspiration signs.

On physical examination, he was alert. His breathing sounds were coarse, with a crackle on the right lower anterior aspect of the chest. The abdomen and other organs were normal. All vital signs were stable, except for a low-grade fever. Laboratory data were as follows: arterial blood gas analysis pH, 7.51; PaCO2, 30 mm Hg; PaO2, 75 mm Hg; HCO3–, 23.9 mmol/L; SaO2, 96%; leukocyte count, 10,740/mm3 (segmented neutrophils 95.1%); hemoglobin, 9.2 g/dL; hematocrit, 28.0%; mean corpuscular volume, 100.4 fl; mean corpuscular hemoglobin concentration, 32.9 g/dL; platelet count, 124,000/mm3; C-reactive protein, 7.84 mg/dL; total protein, 5.0 g/dL; albumin, 2.3 g/dL. Chest radiograph using an anterior-posterior view revealed a cystic lesion in the right medial aspect of the lower lung zone (Figure 1A). Contrast-enhanced computed tomography (CT) of the chest revealed a 5.6×2.5-cm-sized, well-defined, cystic lesion with peripheral enhancement in the right middle lobe, abutting to right minor fissure (Figure 1B–D).

Empirical intravenous antibiotic therapy (piperacillin-tazobactam and levofloxacin) was initiated immediately. An initial sputum culture was negative, as was a sputum acid-fast bacilli (AFB) smear. On the third hospital day, the patient underwent flexible bronchoscopy for microbial evaluation. No endobronchial lesion was apparent, although purulent secretions were noted in the right middle and right lower lobar bronchus. Bronchoalveolar lavage (BAL) was performed in the medial segmental bronchus of the right middle lobe. Analysis of BAL revealed the following: white blood cell count, 4,300/mm3 (segmented neutrophils 94%, lymphocytes 3%, other cells 2%); gram-negative rods, apparent; aspergillus Ag/Ab (IgG), negative/negative; and AFB smear and culture test, negative. On the sixth hospital day, P. mirabilis was identified as the causative organism by culture from BAL fluid. The microbe was resistant to methicillin and ciprofloxacin and was ESBL-positive, but was sensitive to ertapenem; the antibiotic regimen was therefore changed to ertapenem. After 4 weeks ertapenem administration, improvement was detected on clinical finding, laboratory test, and radiologic image, the patient was discharged. At the 2-month follow-up, chest radiography and chest CT indicated resolution of the pneumatocele and pneumonia in the right middle lobe and reduced atelectasis (with consolidation) in the right lower lobe (Figure 2A–C).
Discussion

The genus Proteus currently consists of five named species (P. mirabilis, P. penneri, P. vulgaris, P. myxofaciens, and P. hauseri) and three unnamed genomospecies (Proteus genomospecies 4, 5, and 6). P. mirabilis is one of the most common gram-negative pathogens in clinical specimens and can cause a variety of community or hospital-acquired illnesses. P. mirabilis is not very virulent and is typically considered only to contaminate and colonize wounds, but not to cause serious infection. However, systemic P. mirabilis infections often develop opportunistically in patients with markedly reduced immune capacities, causing urinary tract, biliary tract, and wound infections and peritonitis. Classically P. mirabilis is intrinsically resistant to nitrofurantoin and tetracycline, but susceptible to beta-lactams, aminoglycosides, fluoroquinolones, and trimethoprim-sulfamethoxazole. ESBL expression was initially most prevalent in Klebsiella pneumoniae and Escherichia coli, but is now emerging in other enterobacterial species, including P. mirabilis. Over the last few years, ESBL-positive P. mirabilis isolates have been identified worldwide, composing up to 50% of all isolates in certain areas.

P. mirabilis very rarely causes respiratory infections including pneumonia. P. mirabilis pneumonia is sporadic, and usually not associated with hospital outbreaks. However, Okimoto et al. reported that 13 cases of levofloxacin-resistant P. mirabilis pneumonia occurred in one hospital. Kim et al. reported a nosocomial outbreak in nine hospitalized South Korean patients; 12 non-duplicate multi-drug resistant ESBL-producing P. mirabilis strains were isolated. Bacteria were most frequently recovered from the respiratory tract (n=7), urine (n=3), and wounds (n=2). Such a trend is a matter of major concern, as P. mirabilis is a common cause of human infections (accounting for approximately 3% of all nosocomial infections), and ESBL-producing P. mirabilis strains are usually resistant to several antimicrobial agents and can be difficult to eliminate. The organism is commonly resistant to ceftazidime, cefepime, and fluoroquinolones. Thus, such antibiotics should not be used to treat infections with ESBL-producing P. mirabilis; carbapenems should be the drugs of choice.

Pulmonary pneumatoceles occur as a complication of acute pneumonia, but are almost always transient. The lesions generally resolve spontaneously and completely, without sequelae. The precise pathogenesis of a pneumatocele remains unclear. In one hypothesis, irritation and inflammation of a small bronchiole is thought to trigger formation of a mucus flap, which alternately opens and closes the bronchial orifice, effectively acting as a check-valve. After resolution of the mucus check-valve by mucolytics and antibiotics, the stretched alveoli can be recovered. Invasive interventions may be considered in cases of tension pneumatocele, pneumothorax and infected pneumatocele occur.

Pneumatoceles caused by ESBL-producing P. mirabilis pneumonia have not been previously described in the English-language literature. To the best of our knowledge, this is the first such report. The pneumatocele was initially diagnosed via chest CT, but no complication was evident. Multi-drug-resistant ESBL-positive P. mirabilis was isolated, and the patient successfully treated with ertapenem for 4 weeks, leading to complete recovery.

In conclusion, respiratory physicians should be aware that pneumatoceles can develop in immunocompromised patients with pneumonia caused by uncommon pathogens such as ESBL-producing P. mirabilis. Monitoring of multidrug-resistant strains is needed and physicians should make conscientious efforts to identify organisms causing unusual lung infections.
Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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