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# Multiple Lung Abscesses in a Toddler

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## CASE PRESENTATION

### Initial Presentation and History

A 20-month-old female toddler was transferred from an outside hospital for evaluation of persistent pneumonia. The patient had been in excellent health until approximately 3 weeks prior to transfer, when she developed fever. At that time, her parents reported that she had a cough and high fever over the previous 3 to 4 days. Chest radiography revealed right upper, right middle, and left lower lobe pneumonia (**Figure 1**). She was admitted to the hospital twice and treated with various antibiotics, including ceftriaxone for 4 days, followed by oral cefuroxime axetil for 6 days, parenteral cefuroxime for 4 days, cefuroxime plus vancomycin for 4 days, and finally cefotaxime and clindamycin for 2 days. During this time, the patient's general appearance and cough improved, but she remained intermittently febrile. Her past medical history was unremarkable, and she had no history of exposure to tuberculosis. Because of persistent fever and cough and worsening radiographic disease, she was transferred to our hospital for further evaluation.

### Initial Evaluation

On examination, the patient appeared ill but not toxic, and her temperature was 102°F, heart rate was 128 bpm, respiratory rate was 38 breaths/min, blood pressure was 99/57 mm Hg, and oxygen saturation was 100% on room air. Bronchial breath sounds were noted over the distribution of the right upper lung along with scattered crackles and coarse breath sounds in the remaining right lung and over the left base. Laboratory evaluation demonstrated a white blood cell count of 10,300 cells/μL, with 2% band forms, 32% neutrophils, 52% lymphocytes, and 1% eosinophils; hemoglobin level of 9.3 g/dL; platelet count of 569,000 cells/μL; and an erythrocyte sedimentation rate of 129 mm/hr. Repeat chest radiograph demonstrated multilobar pneumonia with possible cavitation. Computed tomography (CT) scan of the chest revealed a cavitating or necrotizing lesion in the right upper lobe, infiltrates in the left and right lower lobes, and hilar and paratracheal adenopathy (**Figure 2** and **Figure 3**).

At this point in the patient's evaluation, the suspected diagnosis was multilobar pneumonia with necrosis or cavitation and poor response to appropriate medical therapy. Potential explanations for pneumonia unresponsive to antibiotic therapy included complicated pneumonia with necrosis or empyema, lung abscess, infection with an organism not yet considered and/or treated (eg, tuberculosis), or a noninfectious process mimicking infectious pneumonia. Consultation with specialists and more extensive and invasive testing were deemed appropriate.

### Further Evaluation

Repeat CT of the chest several days after the initial CT scan to assess progression of the patient's disease and address apparent lack of response to therapy revealed a round consolidation of the right upper lobe posteriorly with areas of central necrosis and new cavitation. A nodular opacity of the right lower lobe was also noted (**Figure 4**, **Figure 5**, and **Figure 6**). Tuberculosis was considered likely, and the patient was treated with an antituberculosis regimen while awaiting the results of tuberculin skin testing. However, tuberculin skin testing was negative and acid-fast smears of bronchoalveolar lavage specimens were negative; antituberculosis therapy was discontinued and broad-spectrum antibacterial therapy resumed. Given the presence of pulmonary nodular and cavitary lesions and the patient's atypical clinical course, a diagnosis of Wegener's granulomatosis was entertained. Appropriate serologies and CT of the paranasal sinuses were

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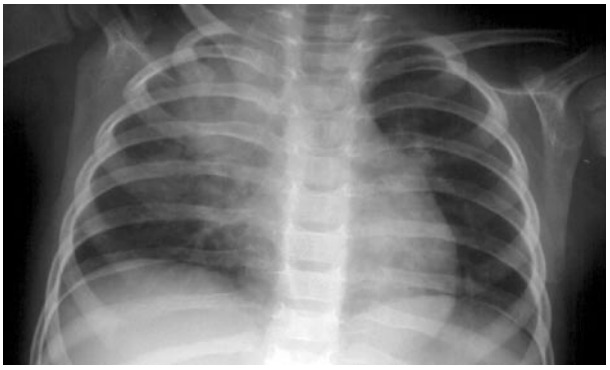

**Figure 1.** Chest radiograph demonstrating multilobar pneumonia.

**Figure 2.** Computed tomography scan of the thorax demonstrating cavitating right lower lobe pneumonia.

negative, but this diagnosis was not completely ruled out, since children with Wegener's granulomatosis may not have positive seromarkers or paranasal sinus disease. Evaluation of the patient's immune system suggested that she was not immunocompromised. The differential diagnosis at this point included necrotizing pneumonia, multiple lung abscesses, Wegener's granulomatosis, tuberculosis, and malignancy.

### Invasive Intervention

Because of the presence of multiple areas of cavitation or necrosis and persistent fevers without a clear etiology, right open lung biopsy was performed. Although needle biopsy was considered, it was determined that open lung biopsy was more likely to yield adequate tissue for diagnosis. Upon thoracoscopic examination, the superior portion of the posterior segment of the right upper lobe, most of the right middle lobe, and the superior portion of the right lower lobe were grossly involved. With biopsy of the right middle lobe, frank pus was unexpectedly encountered and a

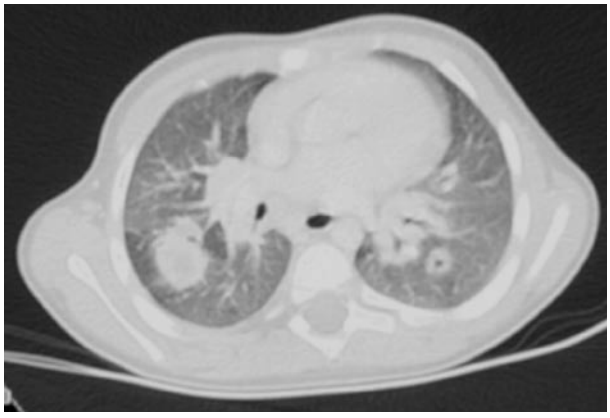

**Figure 3.** Computed tomography scan of the thorax demonstrating bilateral nodular and cavitary disease.

lung abscess was evacuated. Gram stain of tissue from the right middle lobe showed moderate white blood cells, but no organisms were seen. Culture of the pus from the right middle lobe was positive for *Citrobacter freundii* complex. The cavitating right upper lobe lesion was not identified, but a biopsy specimen was obtained. Histopathologic studies of the right upper lobe tissue showed chronic interstitial pneumonitis with focal fibrosis. Histologic evaluation of a biopsy specimen from the right middle lobe revealed bronchopneumonia with abscess formation, edema, and recent hemorrhage; acute and chronic focal bronchiolitis; chronic interstitial pneumonitis; and pleural inflammation, granulation tissue, and fibrosis. A tissue specimen was not obtained from the right lower lobe. Once the culture result was available, the patient's antibacterial therapy was narrowed to cephalosporin monotherapy.

**Key Point**

Although rarely necessary, lung biopsy may be indicated to provide a specific diagnosis in a child not responding to medical therapy. Lung biopsy may be performed in a patient with atypical features or course, a progressive course, rapidly changing findings on chest radiography or high-resolution CT, or a broad residual differential diagnosis despite extensive evaluation and appropriate treatment.

### Case Resolution

Within 36 hours of drainage of the largest lung abscess, the patient defervesced and made a prompt recovery. She completed a 2-week course of cephalosporin monotherapy and has remained healthy.

- **How do lung abscesses develop and how are they classified?**

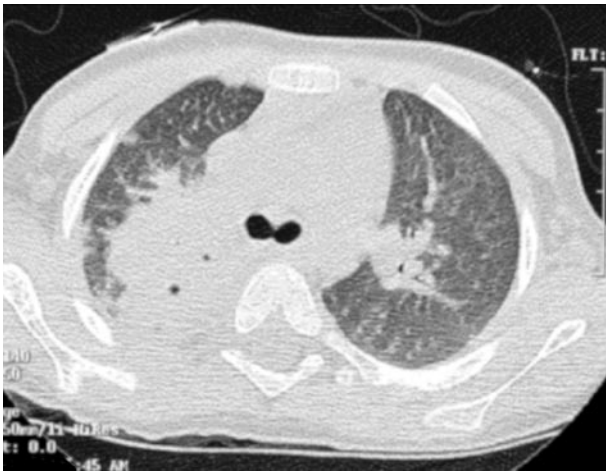

**Figure 4.** Follow-up computed tomography scan of the thorax demonstrating progressive right upper and lower lobe pneumonia with central cavitation.

**Figure 5.** Follow-up computed tomography scan of the thorax demonstrating bilateral lower lobe abscesses.

**Figure 6.** Follow-up computed tomography scan of the thorax demonstrating bilateral lower lobe pneumonia with cavitation of the left side.

- **What organisms cause lung abscess?**

## LUNG ABSCESS

### Definition and Pathogenesis

A lung abscess is a localized area of suppuration and necrosis involving 1 or more areas of the lung parenchyma.[1] Abscesses form as a consequence of infection and destruction of the lung parenchyma with central necrosis, leading to cavity formation and the characteristic radiographic finding of an air-fluid level.[2,3] A lung abscess may decompress and eventually resolve if it communicates with the tracheobronchial tree; however, if no communication develops, the capsule surrounding the necrotic lung and purulent material becomes thick and fibrotic.

Lung abscesses can result from widely variable pathogenic processes,[3] including necrotizing pneumonia,[4] localized infection that occurs after aspiration of heavily infected oral secretions,[5] focal infection of the lung occurring during high-grade bacteremia or as a consequence of septic emboli,[6] or subacute or chronic airway infections.[7] Most frequently, however, the pathogenesis of lung abscess in adults involves aspiration of infective orogingival material and an inability to clear the material. Conditions that may contribute to this pathogenic process include cystic fibrosis, tracheoesophageal fistula, gastroesophageal reflux, immunodeficiency, altered consciousness due to anesthesia and alcohol or drug use, prolonged intubation, tonsillectomy and adenoidectomy, seizures, acute and chronic aspiration, and poor dentition. Pneumonia, high-grade bacteremia, or septic emboli also predispose patients to abscess formation.[4–7] Necrotizing community-acquired bacterial pneumonia is the most common underlying condition in children with lung abscess.[8,9] The case patient had persistent bilateral pneumonia with disease progressing to multiple necrotizing and cavitary lesions in the right lung, as seems to be occurring with increasing frequency in children, particularly those with pneumococcal, streptococcal, or staphylococcal pneumonia.

### Classification

Lung abscesses in adults are classified based on the duration of symptoms prior to presentation (acute or chronic) and the presence or absence of associated

**Table.** Microbiology of Lung Abscess in Children

| | Brook and Finegold[13] | Kosloske et al[14] | Tan et al[15] | Emanuel and Shulman[1] | Zuhdi et al[16] | Total (%) |
|---|---|---|---|---|---|---|
| **Cases (N)** | 10 | 8 | 34 | 18 | 7 | 77 |
| **Aerobic and facultative organisms, no. of isolates** | | | | | | |
| *Staphylococcus aureus* | 1 | 1 | 7 | 6 | 0 | 15 (19) |
| *Streptococcus pneumoniae* | 2 | 0 | 4 | 2 | 0 | 8 (10) |
| Other streptococci | 10 | 4 | 7 | 2 | 2 | 25 (32) |
| *Haemophilus* species | 0 | 1 | 4 | 0 | 0 | 5 (6) |
| *Pseudomonas* species | 2 | 1 | 7 | 0 | 0 | 10 (13) |
| *Klebsiella* species | 4 | 1 | 1 | 1 | 0 | 7 (9) |
| *Escherichia coli* | 4 | 0 | 1 | 1 | 0 | 6 (7) |
| Other gram-positive organisms | 0 | 3 | 0 | 0 | 2 | 5 (6) |
| Other gram-negative organisms | 2 | 0 | 1 | 1 | 6 | 10 (13) |
| **Anaerobic and other organisms, no. of isolates** | | | | | | |
| *Bacteroides* | 9 | 0 | 8 | 0 | 2 | 19 (25) |
| *Prevotella* | 6 | 0 | 0 | 0 | 1 | 7 (9) |
| *Peptostreptococcus* | 10 | 3 | 1 | 0 | 2 | 16 (21) |
| *Fusobacterium* | 2 | 0 | 1 | 0 | 1 | 4 (5) |
| *Veillonella* | 3 | 2 | 1 | 0 | 0 | 6 (8) |
| Other gram-positive organisms | 4 | 0 | 2 | 0 | 0 | 6 (8) |
| Other gram-negative organisms | 0 | 1 | 2 | 0 | | 2 (3) |
| Fungi or yeast | 0 | 1 | 6 | 0 | 1 | 8 (10) |
| Mycobacteria | 0 | 0 | 1 | 0 | 0 | 1 (1) |

conditions (primary or secondary). If symptoms are present for less than 1 month prior to presentation, the lung abscess is considered acute, whereas symptoms present for more than 1 month denotes a chronic lung abscess. A lung abscess is considered primary if the patient had been previously healthy or if the patient is prone to aspiration. Lung abscess in an immunocompromised patient is usually classified as secondary. Such classifications are less helpful for the pediatric age-group, since lung abscess is rarely encountered in these patients.[9] Nonetheless, the case patient would have been described as having a primary lung abscess.

### Microbiology

The microbiology of lung abscess in adults reflects the pathophysiology of the infection. In primary lung abscess, which most often follows aspiration of oral secretions, oral anaerobes, such as *Streptococcus milleri, Bacteroides* species, *Fusobacterium* species, *Peptostreptococcus* species, and others predominate (with 2–3 different anaerobes typically causing polymicrobial infection).[5,10] More recently, as secondary lung abscess in the hospitalized patient has become more common, gram-negative organisms are more frequently implicated.[11,12] In a study of community-acquired lung abscess in adults, *Klebsiella* was the most common organism among the gram-negative bacteria.[12] Compared with the adult population, lung abscess is rare in infants and children.[1–3,13–18] The **Table** outlines causative organisms in several studies of children with lung abscess.[1,13–16]

- **What is the approach to diagnosis and management of lung abscess?**

## DIAGNOSIS AND MANAGEMENT

Pediatric patients with lung abscess present with fever, cough, tachypnea, chest pain, vomiting, weight loss, and, rarely, hemoptysis. Thus, a careful history and physical examination should address these symptoms and findings. The thick fibrotic capsule surrounding the necrotic area of the lung may eventually rupture, resulting in pyopneumothorax and septic shock.[7,8] Adults with lung abscess typically present with symptoms of pulmonary infection, including fever, cough, sputum production, and evidence of chronic disease such as night sweats, weight loss, and anemia. Hemoptysis may

occur. Most patients are aware of putrid sputum or note a sour taste to the sputum. Patients with gram-negative lung abscess generally present in the acute phase of the infection,[5] while those with polymicrobial, largely anaerobic abscesses may have subacute disease.[10] The patient with lung abscess typically is seen during the early phase of pneumonitis; cavitation subsequently evolves on chest radiographs as parenchymal necrosis progresses.

In children and adults, diagnosis is made based on history and physical examination together with findings on imaging studies. Cavitation manifests on radiographs and CT scans with the characteristic finding of an air-fluid level.[2,3] Rarely, sputum, blood, or pleural fluid cultures may suggest an etiology. Even more rarely, specimens for culture can be obtained by transtracheal aspiration and transthoracic needle aspiration in the absence of other positive cultures, but these invasive procedures add little to the empiric therapy for lung abscess. Bronchoscopy is reserved for patients who have an atypical presentation and for those who do not respond to standard therapy with appropriate antibiotics. Although rarely necessary, lung biopsy may be indicated to provide a specific diagnosis in a child not responding to medical therapy. Lung biopsy may be performed in a patient with atypical features or course, a progressive course, rapidly changing findings on chest radiography or high-resolution CT, or a broad differential diagnosis despite extensive evaluation and appropriate treatment.

**Key Point**

Signs and symptoms of lung abscess are nonspecific, and diagnosis requires a thorough evaluation, including detailed history and physical examination, chest radiography, and CT. Cultures of sputum, pleural fluid, and blood are rarely diagnostic in children.

## TREATMENT

Appropriate antibiotic therapy for lung abscess in adults and children is guided by results of cultures, when available. In the absence of positive cultures, empiric intravenous therapy consisting of clindamycin or ampicillin/sulbactam at typical doses is appropriate. Therapy should continue until disease resolution. If the patient is toxic, empiric vancomycin and/or broader gram-negative coverage may be required. Aminoglycosides and other agents are warranted in the presence of risk factors such as cystic fibrosis or immunocompromise. If medical treatment fails, drainage of the abscess is important. For peripheral abscesses, percutaneous aspiration and catheter placement under CT guidance may be performed. Wedge resection, segmentectomy, or lobectomy is reserved for severe cases.

**Key Point**

Results of cultures, when available, guide appropriate antibiotic therapy. If culture results are unavailable, empiric intravenous therapy with clindamycin or ampicillin/sulbactam can be initiated. Antibiotic therapy should be continued until disease resolution.

- **Does *Citrobacter* commonly affect the lungs?**

## CLINICAL FEATURES OF CITROBACTER SPECIES

*Citrobacter* is a gram-negative bacillus related to the *Salmonella* Arizona group of *Enterobacteriaceae.*[19] The genus now contains 11 named species, with 3 traditional species, *C. freundii, C. koseri,* and *C. amalonaticus.*[20] *Citrobacter* species are catalase-positive and oxidase-negative, grow on MacConkey agar, reduce nitrate to nitrite, and grow both aerobically and anaerobically.[20] In the pediatric population, *Citrobacter* species are usually associated with central nervous system infection, specifically meningitis,[21–23] and the organism is typically vertically acquired or nosocomial. Conversely, in adults, *Citrobacter* is typically associated with urinary tract infection.[24] *Citrobacter* species have also been rarely associated with gastroenteritis, osteomyelitis, septic arthritis, omphalitis, pulmonary infections, and bacteremia/sepsis.[25] *Citrobacter* species may be associated with a known focus of infection (eg, pneumonia, catheter infection) or may be the cause of primary bacteremia with no clear etiology. However, bacteremia caused by *C. diversus* commonly arises from the genitourinary tract,[26] while bacteremia caused by *C. freundii* frequently originates in the gastrointestinal tract, particularly in the gallbladder.[26,27]

*Citrobacter* species is a rare cause of infection in the lungs. Aller and Chusid[28] described an ill preterm neonate with *C. koseri*–associated lung abscess and bacteremia not related to meningitic extension. Shamir and colleagues[29] reported a solitary lung abscess caused by *C. diversus* in a preterm infant. Atypical, devastating, *Citrobacter*-associated bronchopneumonia has also been described, with postmortem cultures demonstrating *C. freundii.*[30] Acute purulent pericarditis due to *C. freundii* in a 16-year-old adolescent with a previous history of pneumonia was reported in 2005.[31] To our knowledge, this is the first reported case of multiple lung abscesses due to *Citrobacter.*

## CONCLUSION

Despite the availability of potent antimicrobial agents and advanced diagnostic techniques, lung abscesses remain an important cause of pulmonary disease in infants and children. The case patient presented with disease progression, and because of the atypical course

of her pneumonia and her poor response to antibiotic therapy, a broad differential diagnosis was entertained. Several specialists became involved in the patient's care, and the evaluation became increasingly extensive and invasive to address possible etiologies. Persistent fever, multiple cavitary and necrotic areas of the lung, and the need for a tissue diagnosis prompted open lung biopsy. The histopathologic studies of the tissue revealed chronic interstitial pneumonitis, and culture of the pus grew *Citrobacter.* Multilobar pneumonia may present with atypical or subtle symptoms and may be difficult to diagnose. The prognosis of lung abscesses in children appears to be excellent when treated aggressively with appropriate antibiotics. Drainage is rarely needed. **HP**

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