A 44-year-old man with a history of emphysema presented with 2 days of blood-tinged sputum. Prior to this, he had noticed fever with night sweats, generalized weakness, weight loss, and cough for 2 months. He is a known alcoholic who appeared chronically ill, poorly nourished, and emaciated. He was febrile, and lung auscultation revealed rales over the right upper chest. The blood leukocyte count was 20,000/µL with 87% polymorphs. His blood tested negative for HIV infection, and the skin test result with purified protein derivative was negative. Chest radiography (Fig 1) revealed patchy airspace disease with areas of lucency suggestive of cavitation in the right upper lobe, and emphysematous changes bilaterally. A CT scan of the chest (Fig 2) revealed a crescent-shaped lucency (air crescent sign) within the area of consolidation in the right upper lobe. Multiple sputum smears revealed no bacteria and no acid-fast bacilli. Sputum cultures revealed no bacterial growth. The patient underwent fiberoptic bronchoscopy that revealed only purulent secretions in the right upper lobe bronchus without any endobronchial lesions. Lavage smears revealed no bacteria or acid-fast bacilli. Four weeks of treatment for tuberculosis resulted in no clinical or radiographic improvement.

What is the diagnosis?

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Diagnosis: Chronic necrotizing pulmonary aspergillosis complicated by pulmonary gangrene.

A repeat CT scan of the chest (Fig 3) 4 weeks after initial presentation revealed that the area of consolidation in the right upper lobe containing the air crescent sign was replaced by a cavity with an intracavitary mass. Both sputum and lavage samples revealed no bacteria or mycobacteria, but did reveal growth of *Aspergillus niger*. Treatment for tuberculosis was discontinued, and itraconazole was started with subsequent clinical and radiographic improvement.

**DISCUSSION**

The spectrum of Aspergillus lung disease includes saprophytic aspergillosis in the form of pulmonary aspergilloma, immune disease in the form of allergic bronchopulmonary aspergillosis and hypersensitivity pneumonitis, and infectious disease in the form of invasive and semi-invasive necrotizing aspergillosis. Chronic necrotizing pulmonary aspergillosis is an uncommon, subacute, locally invasive form of aspergillus lung infection that has also been referred to as semi-invasive pulmonary aspergillosis. It has been described in patients with altered local defense due to preexisting lung disease and in patients with mildly compromised systemic defenses. The disease evolves slowly over several weeks to months as airspace disease in the upper lobes, which often progresses to cavitation and lung abscess formation due to inflammatory necrosis. Ischemic necrosis due to vascular invasion and endarteritis leads to the development of lung gangrene. When this occurs, the nonviable or gangrenous part of the diseased lung initially separates from the more viable lung parenchyma creating a rim of lucency called the air crescent sign (Fig 2). The devitalized portion of lung then completely demarcates itself from the surrounding lung and appears as an intracavitary mass (Fig 3). This radiographic sequence is characteristic of pulmonary gangrene. The air crescent sign may be visualized on chest CT well before it is seen on the chest radiograph.

Pulmonary gangrene as a complication of necrotizing pneumonia has been described in patients infected with *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Pseudomonas aeruginosa*, *Polymicrobial anaerobes*, *Mycobacterium tuberculosis*, *Aspergillus* species, and species of the order Mucorales. When this process of pneumonia, necrosis, and lung gangrene formation follows an indolent course, *M tuberculosis* and fungi of the Aspergillus species are the most likely pathogens.

Chronic necrotizing pulmonary aspergillosis has been described in patients with chronic alcohol abuse, chronic obstructive airway disease, interstitial lung disease, malignancy, diabetes mellitus, and in patients receiving long-term corticosteroid therapy. The patient usually presents with cough, weight loss, hemoptysis, and fever of few weeks to a few months duration, thereby mimicking tuberculosis and often resulting in a delay in the diagnosis.

Radiographic findings are that of focal consolidation, sometimes mass-like and often with pleural thickening usually involving the upper lobe. The necrotizing nature of the infectious process leads to cavitation and formation of a lung abscess. Ischemic necrosis due to fungal vascular invasion and thrombosis results in parenchymal necrosis with infarction at the center of the consolidation. The development of lung gangrene can be recognized radiographically with the appearance of an air crescent within the consolidation that progresses to the formation of a cavity with an intracavitary mass.

Three histologic patterns of chronic necrotizing pulmonary aspergillosis have been described. Necrotizing granulomatous pneumonia, wherein ischemic necrosis leads to infarction and lung gangrene at the center of the consolidation, as seen in the patient we describe. It is in this form of the disease that the air crescent sign will serve as the radiographic clue to the ongoing ischemic necrosis. Second is that of a preformed cavity containing a fungal ball but differing from the saprophytic pulmonary aspergilloma, in that there is invasion and destruction of adjacent lung tissue by the fungus. This represents saprophytic aspergillosis that has evolved into locally invasive disease often the result of steroid use. A third pattern is that of primary bronchiolar infection and inflammation with invasion...
of surrounding lung parenchyma, with some resemblance to bronchocentric granulomatosis.

While growth of Aspergillus species in sputum or bronchial secretions provides supporting evidence of the infection, demonstration of fungal tissue invasion by biopsy or lung resection is usually needed to establish the diagnosis. Until recently, systemic amphotericin B with its known toxicity was the cornerstone of treatment. Few patients have been successfully treated with intracavitary instillation of amphotericin B. Treatment failures with amphotericin B have been described resulting in the need for surgical resection. Mortality rates of 26 to 60% have been reported, and delay in diagnosis is often implicated. Itraconazole has been shown to be an effective form of treatment with high clinical and mycologic cure rates, and replaces amphotericin B as initial therapy.

Chronic necrotizing pneumonia may be the manifestation of anaerobic lung infection, tuberculosis, chronic necrotizing aspergillosis, actinomycosis, nocardiosis, and histoplasmosis. The development of pulmonary gangrene in such patients limits the possibilities to tuberculosis or chronic necrotizing aspergillosis. The absence of acid-fast bacilli and the presence of Aspergillus species in bronchial secretions in this setting allow for a diagnosis of chronic necrotizing pulmonary aspergillosis and the institution of itraconazole therapy. The high morbidity and mortality of the disease is in part due to delayed diagnosis, with a reported average delay of up to 7 months in several series. To ensure prompt diagnosis, Aspergillus infection must be considered when faced with a chronic necrotizing pneumonia, especially with radiographic features of ischemic necrosis, ie, lung gangrene. The need to be familiar with the radiographic and CT signs of pulmonary gangrene therefore cannot be overemphasized, and the air crescent sign remains a useful diagnostic clue.

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