

## February 2013 Critical Care Case of the Month: Thoracentesis Through the Looking Glass

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### ***History of Present Illness***

A 62 year old man was recently diagnosed with Stage 4 squamous cell left lung cancer with metastases to the pleura, brain and mediastinum. He also had known chronic obstructive pulmonary disease (COPD) with a FEV1 = 1.96 L and a known left side pleural effusion (see Figure 1).

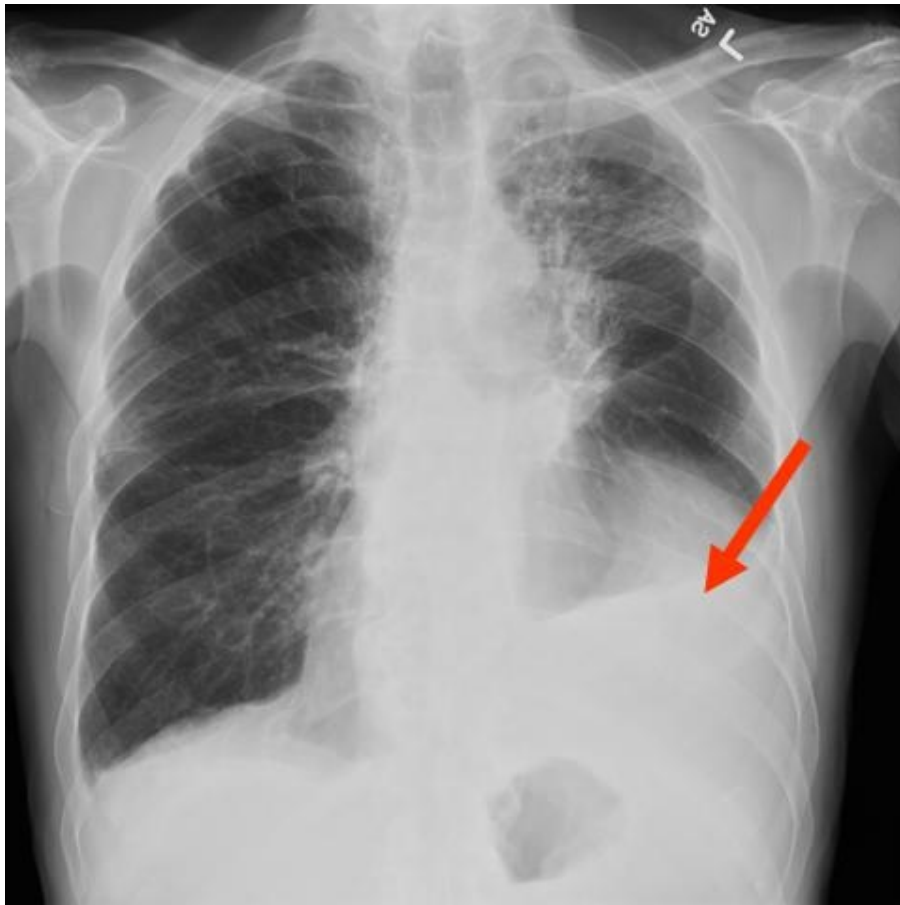


Figure 1. Baseline chest radiograph showing left pleural effusion (red arrow).

He was seen as an outpatient for symptomatic shortness of breath and underwent real time ultrasound guided left sided thoracentesis removing 500 ml of straw-colored fluid. The procedure was uneventful except that near the end, the patient started to cough. He denied any symptoms post procedure apart from some minor puncture site pain. A routine post procedure chest x-ray was performed (Figure 2).

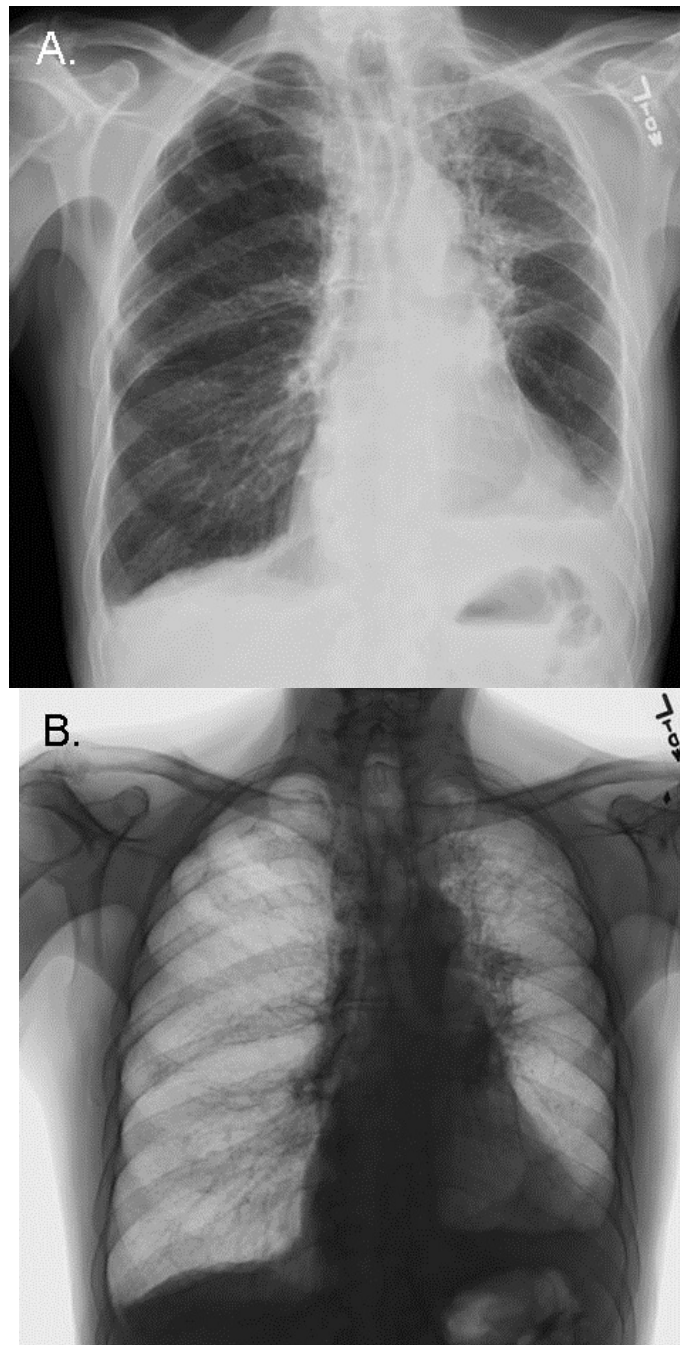


Figure 2. Post-thoracentesis x-ray (Panel A) and its negative image (Panel B).

What **new abnormality** is identified on the post-procedure chest x-ray?

1. Left pneumothorax
2. Right pneumothorax
3. Lung “sliding” on the left
4. New pneumonia in the left upper lobe
5. Left hilar retraction

**Correct!**  
**2. Right pneumothorax**

Air in the pleural space, a pneumothorax, is a well-known complication of thoracentesis. It usually occurs because of air entering the pleural space during the needle insertion. However, this pneumothorax was on the contralateral side of the thoracentesis. There is both hilar retraction and left upper lobe changes on the post-thoracentesis radiograph, but these were present on the baseline radiograph shown in Figure 1. Lung sliding is when respiratory movement can be observed at the lung surface during ultrasound (1). If present, lung sliding rules out a pneumothorax. Some studies report that the bedside ultrasound is better than CXR for ruling out pneumothorax (2).

In our patient, a post procedure ultrasound showed clear unambiguous lung sliding on the left side. The fluid cytology was negative for malignancy. There was disagreement between the clinicians and the radiologists about the presence of a right-sided pneumothorax. However, the patient was asymptomatic and wanted to go home to his home east of Phoenix at an elevation of about 5000 feet.

Which of the following are **true**?

1. A thoracic CT scan could convincingly rule out a pneumothorax
2. Tube thoracostomy needs to be performed in all cases of pneumothorax
3. A pneumothorax may expand at high altitude
4. A + C
5. All of the above

**Correct!**  
**4. A + C**

Asymptomatic pneumothoraces do not always need drainage and this depends on the patient's comorbidities (2). A rough rule of thumb is a 10% or larger pneumothorax may need drainage, smaller ones usually do not. Depending on the patient, interventions may be required. For example, a patient with severe pulmonary fibrosis and a 5% pneumothorax may benefit from intervention. However, in this case, the patient was completely asymptomatic and had good home support, transport and monitoring and therefore normally could have been sent home. The reason he was not, is that he lived at a much higher altitude. Based Boyle's law sending him to a higher altitude with a pneumothorax would likely have led to a significant increase in size. Boyle's law states that pressure and volume are inversely related such that  $P_1V_1 = P_2V_2$ , in a closed system at a constant temperature. While in theory the patient is not a closed system, the law still applies to the pneumothorax which is almost a closed system.

The gold standard for diagnosis of pneumothorax is a thoracic CT (2). Since there was disagreement about interpretation of the chest x-ray, a thoracic CT was performed (Figure 3).

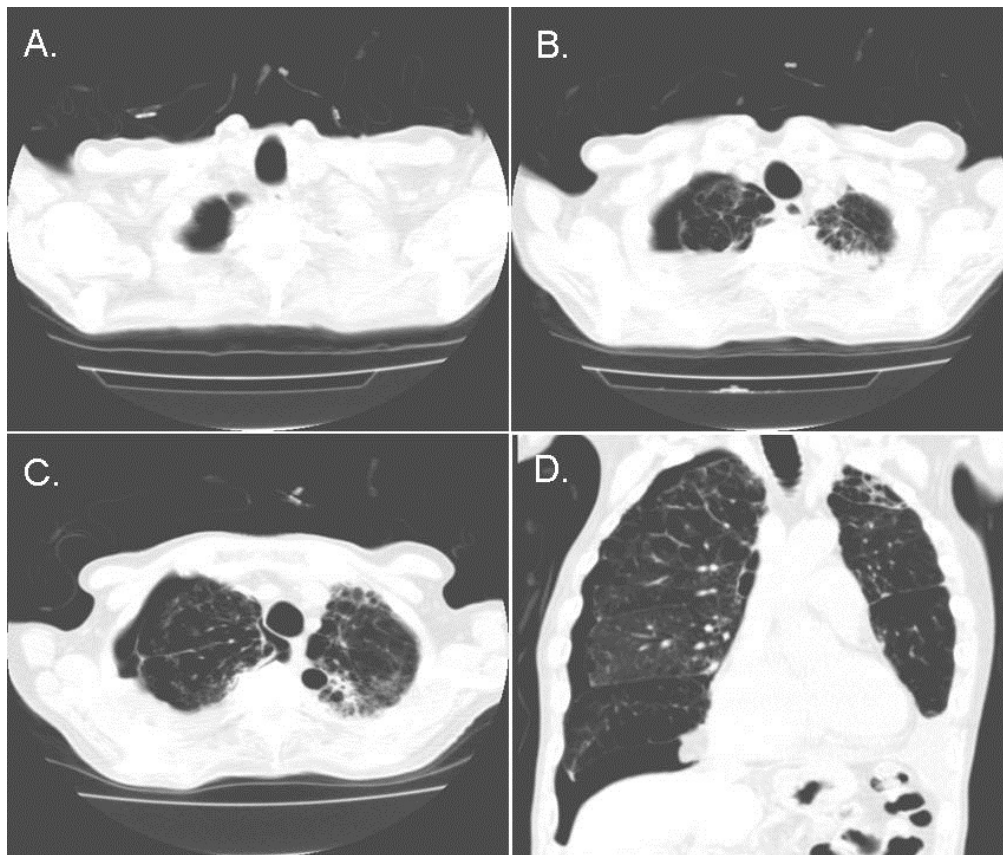


Figure 3. Representative images from thoracic CT scan.

What **abnormalities** does the thoracic CT scan show?

1. Left pleural effusion
2. Right pneumothorax
3. Right hydropneumothorax
4. Bullous emphysema
5. All of the above



**Correct!**  
**5. All of the above**

There is a right-sided pneumothorax consistent with previous chest x-ray findings and a component of right hydropneumothorax with a small to moderate sized right pleural effusion and an air interface (Figure 4, red arrows).

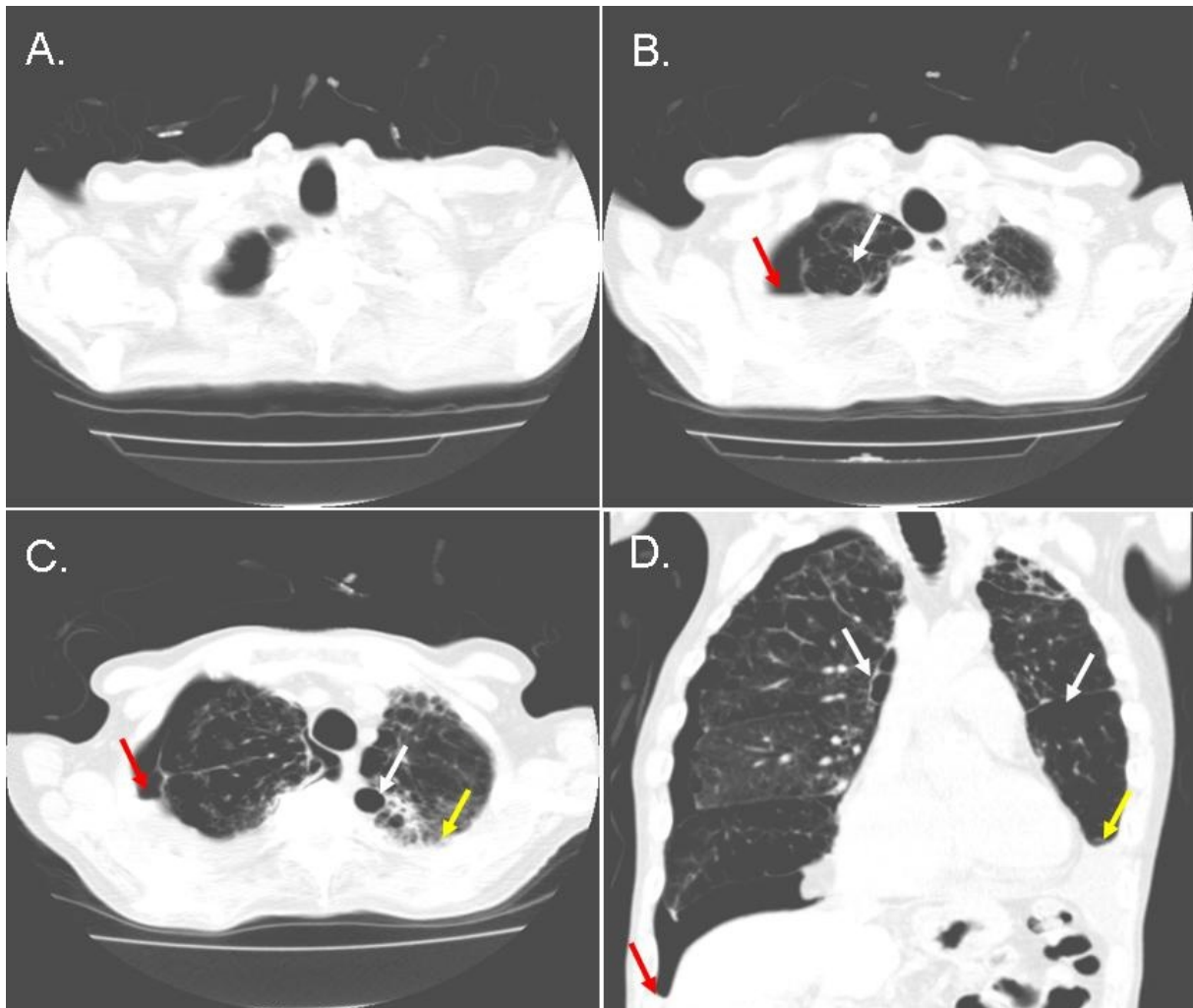


Figure 4. Thoracic CT scan with some of the abnormalities indicated by arrows (see text for description).

There are extensive emphysematous changes throughout the lungs with multiple large bulla or bleb as above involving the bilateral lung apices and bilateral lung bases (Figure 4, white arrows). There is a small to moderate left-sided pleural effusion (figure 4, yellow arrows).

The patient had a chest tube placed for drainage of the pneumothorax. An air leak was observed continuously for the next 3 weeks. A chest x-ray after 3 weeks is shown in Figure 5.

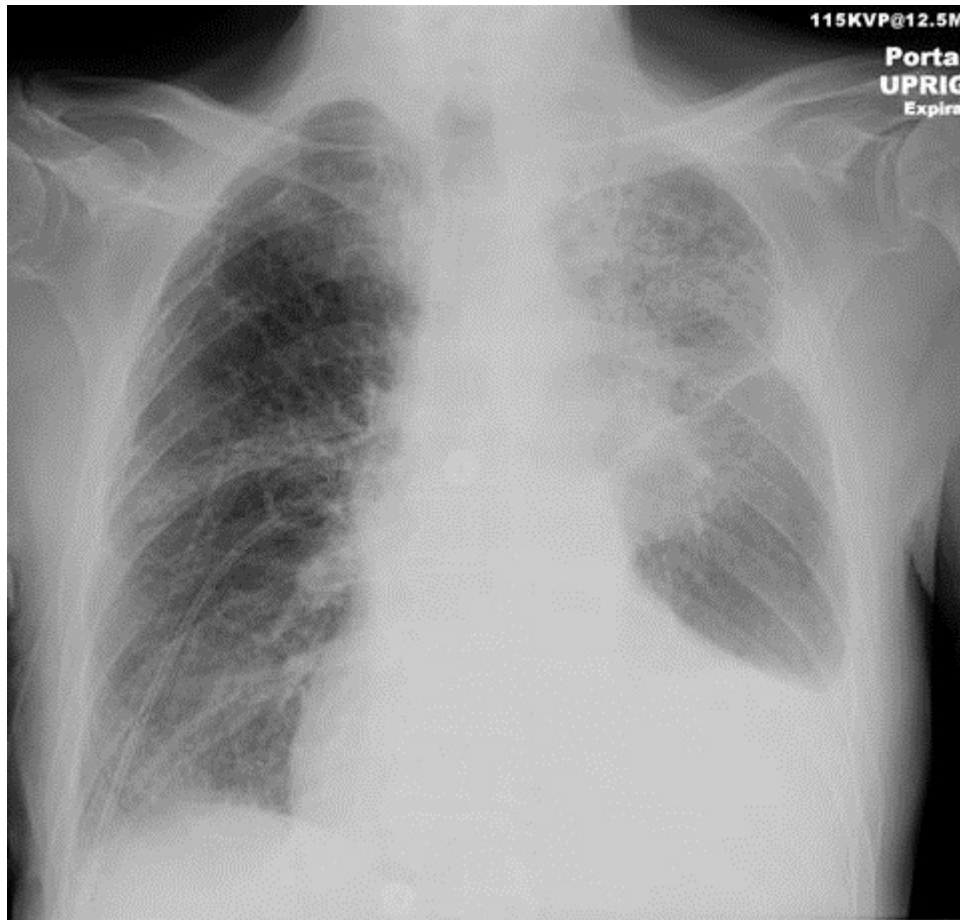


Figure 5. Chest radiograph taken after 3 weeks of continued drainage.

Which of the following are ***true***?

1. An air leak is indicated by bubbling at the water seal in the pleural drainage system.
2. The pleural drainage system should be carefully checked for a source of an air leak.
3. The patient may have a bronchopleural fistula.
4. Thoracic surgery consultation should be obtained.
5. All of the above



**Correct!**  
**5. All of the above**

A second tube was inserted which also showed an air leak indicated by bubbling at the water seal in the pleural drainage system. Over the 3 weeks, the tubes were repeatedly examined and tested to ensure that air leak was coming from the patient's thorax, and not the tube or the drainage system. The skin entry sites were examined and confirmed to be air tight to prevent ingress of atmospheric air. The tubes were variously placed on suction, water seal, clamped, unclamped, and placed back on suction several times. The pneumothorax persisted despite of this, and the diagnosis of a persistent bronchopleural fistula was made and various options were discussed for treatment. The thoracic surgery service saw the patient but did not recommend surgical intervention by VATS or thoracotomy.

Which of the following are treatment options for a persistent bronchopleural fistula?

1. Watchful waiting
2. Reduce the transpulmonary pressure gradient
3. Pleurodesis
4. Intrabronchial one-way valve
5. All of the above

**Correct!**  
**5. All of the above**

A bronchopleural fistula is a leak between the proximal bronchi and the pleural space. They may happen after trauma or thoracentesis and often resolve spontaneously. When they do not resolve, they are often difficult to treat due to nature of the underlying disease that predisposes to their development (COPD, severe lung disease or trauma). To prove there is a bronchopleural fistula, the chest tube system must be carefully examined to ensure that there is no leak in the system, the tubing or at the entry site. Only when these are ruled out can a bronchopleural fistula be diagnosed. Treatment options have not been studied in a randomized fashion but the following are generally considered:

1. Watchful waiting since most will spontaneously resolve.
2. Reducing transpulmonary pressure gradients, i.e. lowering the pleural pressure gradient by avoiding positive pressure ventilation (NIV or intubation) and/or taking the tubes off negative pressure suction and leaving the tube on water seal
3. Pleurodesis either at bedside or by surgical VATS
4. Bronchoscopy to find the source and then attempting various glues/gels or intrabronchial valves.

After 3 weeks conservative measures had failed. An Olympus intrabronchial one way valve system (IBV) was inserted. IBVs are one way valves that allow air to leave the lung but not enter the lung (i.e., allow exhalation but not inhalation). Due to sedation issues, the patient was electively intubated for this. He was not hypoxic or *in extremis* at the time. The patient underwent bronchoscopic placement of several of these on the right side.

The post IVB valve placement CXR is shown in Figure 6.

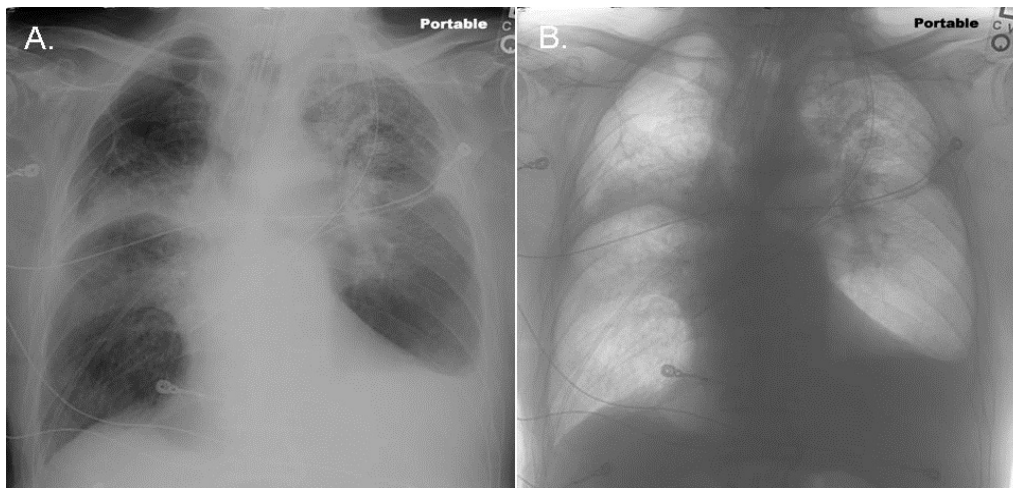


Figure 6. Post intrabronchial valve insertion chest radiograph (Panel A) and its negative image (Panel B).

The patient was much more hypoxia after the procedure than before, and had to be placed on 100% oxygen and his PaO<sub>2</sub> was only 60 mm Hg.

What is the **most appropriate** therapy at this time?

1. Increase positive end expiratory pressure
2. Place patient with his left side down
3. Place patient with his right side down
4. Begin extracorporeal membrane oxygenation (ECMO)
5. All of the above

## **Correct!**

### **2. Place patient with his left side down**

The post IVB chest x-ray shows a slightly larger right sided pneumothorax than before the IBV placements. The reason for this is likely atelectasis due to the correct functioning of the valves. The hypoxia, is hence, a result of this atelectasis and the associated areas of low VQ ratios (shunt). The patient was temporarily treated by turning him onto his left side, i.e. right side up. This improved his hypoxia by improving perfusion (Q) to the better lung and reducing perfusion (Q) to the shunting right lung. In most cases with IBVs, the degree of shunt physiology is moderate to minimal and resolves over a few hours.

The air leak was significantly reduced in this patient by this measure but not to the point of the patient tolerating a Heimlich valve attached to the chest tube. He was transitioned to palliative care and lived the rest of his short life in relative comfort with family

### **Pearls**

- Spontaneous contralateral pneumothoraces are rare complications of thoracentesis.
- Bronchopleural fistulas are difficult to treat; fortunately, only a minority are persistent.
- Intrabronchial valves are a new and potentially useful intervention for refractory bronchopleural fistulas.

### **References**

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