diagnosed in April 1987; at that moment the radionuclide bone scan was normal. One year later, the bone scan showed a solitary hot spot in a rib. At autopsy, this rib lesion was the only skeletal metastasis. Therefore, we do not think that bone lysis by skeletal metastases is the explanation for the patient's hypercalcemia. Moreover, the association of hypercalcemia, hypophosphatemia, decreased PTH levels and increased urinary cAMP excretion in our patient suggests the action of an adenylate cyclase stimulating factor (a PTH-like peptide?), causing a humorally mediated hypercalcemia.

REFERENCES
4 Weiss SW, Dorfman HD. Adamantinoma of long bone: an analysis of nine new cases with emphasis on metastatizing lesions and fibrous dysplasia-like changes. Hum Pathol 1977; 8:141-53

Heimlich Valve Treatment of Pneumocystis carinii-Associated Pneumothorax*

Albert G. Driver, M.D., F.C.C.P.;† James G. Peden, M.D.;‡ Harry G. Adams, M.D.;‡ and Richard L. Runley, M.D.‡

Two patients were treated for AIDS-associated bilateral pneumothoraces which persisted despite prolonged chest tube drainage. Heimlich flutter valves were used to facilitate the outpatient management of these patients.

(CHEST 1991; 100:281-82)

Numerous reports have appeared in the past few years of spontaneous pneumothoraces occurring in patients with the acquired immunodeficiency syndrome and Pneumocystis carinii pneumonia.1-5 Pneumothorax and bronchopleural fistula are believed to occur as a result of lung destruction by Pneumocystis organisms.1-5 Like many other complications of AIDS, pneumothorax can have devastating physical and psychologic consequences, since prolonged hospitalization and chest tube drainage may be required. Standard surgical approaches for the treatment of refractory or recurrent spontaneous pneumothoraces may not be advisable in AIDS patients, especially when the pneumothoraces occur bilaterally. We describe two patients with P carinii-associated bilateral pneumothoraces where Heimlich valves were used to maintain lung inflation in an outpatient setting.

CASE REPORTS

Case 1
The patient was a 31-year-old man with a two-year history of AIDS. He had complications of P carinii pneumonia and cytomegalovirus retinitis. The patient was doing well on prophylactic aerosolized pentamidine, 100 mg every two weeks, when he suddenly developed shortness of breath and chest tightness. A chest x-ray film demonstrated large bilateral pneumothoraces and bilateral airspace disease. Bilateral chest tubes were inserted and connected to suction. Pneumocystis carinii organisms were isolated from bronchoalveolar lavage fluid. Pentamidine, 800 mg intravenously once a day, was administered. After two weeks of pentamidine therapy, pulmonary infiltrates resolved and pentamidine was changed to aerosolized therapy with 60 mg given once a week. When the pneumothoraces failed to resolve with prolonged chest drainage, pleurodesis with tetracycline was attempted bilaterally three times over a five-week period without success. Bilateral pneumothoraces recurred on each occasion after suction was discontinued. Pleural fluid drainage averaged 10 to 20 ml/day from each chest tube. Surgical intervention was considered but was not recommended. Finally, after ten weeks of hospitalization with chest tube drainage, the patient requested discharge from the hospital. The chest tubes were then attached to Heimlich valves with drainage bags and the patient was discharged. Very small apical pneumothoraces were present on a chest roentgenogram taken prior to discharge (Fig 1). One week after discharge, the patient was readmitted for treatment of a small empyema in the left chest. Pneumothoraces were not present on a chest roentgenogram at that time. Pleural fluid cultures were positive for Staphylococcus aureus, Proteus mirabilis, and Morganella morganii. The empyema resolved with appropriate antibiotic therapy. The left chest tube was successfully removed three weeks and the right chest tube six weeks after placement of the Heimlich valves. No further pneumothoraces have occurred since the subsequent nine months.

Case 2
The patient was a terminally ill 33-year-old man with a two-year history of AIDS complicated by P carinii pneumonia, cytomegalovirus retinitis with blindness, and severe weight loss. Four months prior to admission, he developed a right spontaneous pneumothorax which resolved without chest tube drainage. The patient continued on treatment with prophylactic pentamidine aerosol therapy. The patient developed a paroxysm of coughing followed by sharp right chest pain and shortness of breath. A chest roentgenogram revealed a large right pneumothorax with small bilateral pleural effusions. Pulmonary parenchymal abnormalities were not observed. The patient was hospitalized and a chest tube was inserted and attached to a Heimlich valve. The pneumothorax persisted but was smaller. Three days after admission, a large left pneumothorax was discovered and a chest tube was inserted in the left chest. Despite insertion of an additional chest tube on the right, small bilateral pneumothoraces persisted despite suction drainage with a pressure of ~30 cm H2O. He refused to have bronchoscopy, and empiric therapy for Pneumocystis pneumonia was started and consisted of aerosolized pentamidine, 600 mg/day, dapsone, and trimethoprim. When no resolution of the pneumothoraces occurred after five days of antibiotic therapy and 27 days of chest tube drainage, the patient requested discharge from the hospital. Heimlich valves and drainage bags were then attached to the ends of the chest tubes, and the patient was discharged. A chest roentgenogram taken prior to discharge showed small bilateral pneumothoraces. This is shown in Figure 1, right. The patient did well at home for one week following discharge until excessive pleural fluid drainage interfered with function of the Heimlich valves. The patient refused further medical

*From the Department of Medicine, East Carolina University School of Medicine, Greenville, NC.
†Assistant Professor.
‡Associate Professor.

CHEST / 100 / 1 / JULY, 1991 281
intervention, and he died at home seven weeks later.

**DISCUSSION**

An increasing number of reports of spontaneous pneumothorax in AIDS have appeared recently in the medical literature. Spontaneous pneumothorax has been associated with *P. carinii* infection and also with prophylactic pentamidine aerosol therapy. Most reported cases appear to occur as a preterminal event in chronically-ill patients. Chest tube insertion is usually required for management. One reported patient with sequential left and right pneumothoraces was treated with thoracotomy and pleurectomy after the pneumothoraces persisted with prolonged chest tube drainage.

Short-term chest tube drainage alone was inadequate therapy for pneumothorax in our two patients. This was primarily due to an inability to fully expand the lung caused by bronchopleural fistulas. We were unable to fully inflate the lung despite suction pressure, preventing the visceral and parietal pleural surfaces from sealing off the air leak. Likewise, therapy for *Pneumocystis* in both our patients did not improve lung expansion. Our choice of therapy with aerosolized pentamidine may not have been optimal due to inadequate penetration of the drug into atelectic areas of lung. Coughing caused by airway irritation from pentamidine may aggravate the air leak and delay closure of the bronchopleural fistula. Three attempts at pleurodesis with tetracycline in patient 1 were not successful. Failure of tetracycline pleurodesis in this situation has been reported. Finally, as a last resort, Heimlich valves were attached to the ends of the chest tube. Therapy with Heimlich valves permitted ambulation and outpatient management in both of our patients. Pneumothoraces resolved over three to six weeks, and chest tubes were successfully removed from patient 1. This treatment provided patient 2 with one week of freedom from dyspnea at home. We suspect that malfunctioning chest tubes may have contributed to his death. Heimlich valves have been applied in the treatment of spontaneous pneumothorax in patients without AIDS and have successfully permitted outpatient therapy. By acting as a one-way valve, Heimlich flutter valves permit egress of pleural air while sealing the chest tube on inspiration. Attachment of a drainage bag to the valve permits collection of potentially infectious fluid in AIDS patients, although the valves tend not to work well in the presence of pleural fluid drainage. Heimlich valves appear to offer a reasonable outpatient treatment in refractory pneumothorax in patients with AIDS.

**REFERENCES**