well; however, three months later, a chest x-ray film revealed a nodule in the right upper pulmonary field, with widening of the mediastinum. Subsequently, multiple nodules developed in both pulmonary fields. Biopsy of a lesion on the abdominal wall revealed metastatic undifferentiated bronchogenic carcinoma. The patient received no apparent benefit from radiation therapy to the right hemithorax or from a course of therapy with 5-fluorouracil. His condition progressively deteriorated, and the patient died ten months after the initial pneumothorax. Permission for autopsy was refused.

**DISCUSSION**

Our case is unusual because the patient was much younger than those previously reported; however, he had smoked excessively (five packs of cigarettes daily) for approximately three years preceding his illness. The youngest patient previously reported, a 39-year-old man, had also smoked heavily (one to three packs of cigarettes per day since the age of 13 years).²

We found five reports of confirmed bronchogenic carcinoma accompanied by pneumothorax with satisfactory subsequent reexpansion of the pneumothorax (four of Citron’s³ cases and one reported by Seremitis and MacDonald²).

The recurrence of a pneumothorax, particularly after satisfactory reexpansion via a chest tube, should suggest the possibility of underlying malignant disease.

**REFERENCES**

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**Extracorporeal Membrane Oxygenator Support for Pulmonary Insufficiency**

**Estimating the Need**

**To the Editor:**

In a letter to the editor of Chest last year, Mortensen¹ speculated about the need for extracorporeal membrane oxygenation for acute respiratory failure. Based upon his review of cases at a representative teaching hospital, he concluded that approximately 40 percent of the patients who died of pulmonary insufficiency (about 20 patients per year) were candidates for extracorporeal membrane oxygenation. This estimate is not in line with our experience, and it is the purpose of this communication to document the limited application which we have found for pulmonary support via extracorporeal membrane oxygenation.

Beginning in 1973, we developed the capability to provide extracorporeal membrane oxygenation at the Upstate Medical Center in Syracuse, NY. A description of our setup² and the successful experience of one of us³ at another institution have been published. In spite of the fact that our center is a referral area for central New York and that many patients with pulmonary problems are seen here, we found no occasion to use our capability for extracorporeal membrane oxygenation. Because of this, we did a retrospective analysis of all patients during a six-month period to find out if we might have missed patients who could have benefited from extracorporeal membrane oxygenation.

During the period studied, there were 6,270 patients hospitalized, of whom 255 died (mortality, 4 percent). Because of the liberal application of blood gas measurements, we investigated with a detailed analysis the patients who had two or more determinations of blood gas levels. There were 631 of these patients, and 94 of these patients died (mortality, 15 percent). The blood gas values and the fractional concentration of oxygen in the inspired gas (FIO₂) for the 631 patients were entered on computer cards for each of the patients. Criteria for defining pulmonary insufficiency were the following values for arterial oxygen pressure (PaO₂) with the patient receiving various FIO₂:

- PaO₂ < 60 mm Hg with the patient breathing room air; 70 mm Hg with FIO₂ of 0.4; 80 mm Hg with FIO₂ of 0.6; 90 mm Hg with FIO₂ of 0.8; and 100 mm Hg with FIO₂ of 1.0.

There were 253 patients who could be defined as having pulmonary insufficiency by these liberal criteria, but only six of them died with a PaO₂ less than 50 mm Hg. A review of the records of these patients showed that all six patients died in circumstances which precluded use of extracorporeal membrane oxygenation. The causes of pulmonary insufficiency in these six patients were as follows (reason to deny extracorporeal membrane oxygenation in parentheses): (1) aspiration (bleeding varices); (2) pulmonary contusion (subarachnoid hemorrhage); (3) transplant rejection (generalized sepsis); (4) transplant rejection (septic shock); (5) postoperative tetralogy (hemorrhage); and (6) cardiac failure (hemochromatosis).

All of these patients meet the criteria for exclusion given in the protocol for Extracorporeal Support for Respiratory Insufficiency (National Heart and Lung Institute Collaborative Program, May 15, 1974). Therefore, no patients met the criteria for inclusion in the same document, which are a PaO₂ of less than 50 mm Hg on FIO₂ of 1.0 in rapidly failing patients and a PaO₂ of less than 50 mm Hg on FIO₂ of 0.6 with a shunt greater than 30 percent in patients who fail more slowly.
It is true that we could have been more liberal in our choice of patients for this treatment, but the review of our experience shows that patients did not die because of our conservative stance.

Our conclusion is that conventional ventilator therapy is adequate in a great majority of patients with pulmonary insufficiency, so that it will be an unusual situation where extracorporeal membrane oxygenation can be applied. We believe that the factors which make conventional ventilator therapy effective are (1) the use of a volume cycle respirator early at high tidal volume (15 to 20 ml/kg) and positive end-expiratory pressure of 5 to 15 cm H₂O (we have found such a regimen safe); and (2) maintaining an FIO₂ less than 40 percent (only 20 of the patients in our study had an FIO₂ of 0.6 to 1.0, and only 28 had values of 0.4 to 0.6).

The capability for extracorporeal membrane oxygenation can be maintained in any institution in which open-heart surgery is done if plans are made and protocols are developed for its implementation in the rare cases where conventional treatment fails.

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REFERENCES

To the Editor:

Little or no disagreement exists between our experience and that of the Upstate Medical Center group reported by Hanson et al. Our communication¹ was written for the same purpose as that of Hanson and associates, namely, to indicate the relatively infrequent occurrence in current medical practice of candidates for extracorporeal membrane oxygenation, under present criteria or indications. Our retrospective study of 500 consecutive deaths in the Latter-Day Saints Hospital (Salt Lake City) during 1971 and 1972 led us to conclude that only about 20 of these patients "could be considered potential candidates for mechanical ECMO pulmonary assist, had that form of treatment been available at the time."²¹(9119) We agree that this is somewhat at variance with the experience quoted by our New York colleagues. We also agree that it is somewhat out of line with our own experience during the immediate past two years, when we have been using extracorporeal membrane oxygenation for carefully selected cases. We believe that two factors account for this overestimate of potential candidates for extracorporeal membrane oxygenation:

First, our published communication¹ erroneously stated we might expect 20 potential candidates per year. Actually, the study was for two years, so we really expected only ten potential candidates per year. A similar error occurred in the first conclusion of our original communication,¹ when the words, "per year," should have been deleted.

Secondly, the study we conducted dealt with acute respiratory insufficiency as treated in 1971 and 1972. We are in full agreement with Hanson and associates that ventilator therapy as currently (1976) administered, with high tidal volumes and adequate positive end-expiratory pressure, will effectively move the great majority of patients with respiratory insufficiency out of the classification of respiratory failure and, thus, make consideration of extracorporeal membrane oxygenation unnecessary; however, in 1971 and 1972, ventilator therapy was considerably less aggressive or effective, so more patients died of hypoxemia than do similar patients today, either in New York or in Utah.

We might also add that in the past two years, at the same hospital where our study in 1971 and 1972 suggested that we would see 20 possible candidates for extracorporeal membrane oxygenation, we have actually seen only ten who have met the criteria for entry into the National Heart and Lung Institute collaborative study. This is in agreement with the suggestion of Hanson et al that our estimates were "not in line." Here again, we believe that improvement in ventilator therapy during the last few years and the continued stringent criteria for use of extracorporeal membrane oxygenation account for the overestimate of the number of bona fide candidates for extracorporeal membrane oxygenation suggested by our study during 1971 and 1972.

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REFERENCE