Superimposed High Frequency Ventilation with Conventional Mechanical Ventilation

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A 73-year-old man with ARDS-multiple organ failure due to Chlamydia psittaci, was successfully supported with conventional respiratory techniques. After 48 hours of no clinical improvement, HFV was superimposed to CMV in order to combine the advantages of each one. Since improvement has been seen in all ventilatory parameters, this method is suggested as another mode of ventilation for patients with refractory hypoxia and hypercarbia who do not respond to conventional respiratory care.

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Despite the growing understanding of ARDS, therapeutic advances are few. Many respiratory supportive techniques have been attempted, but there is no agreement about the correct approach to these patients. The usual mode of IPPV is effective in solving the problems of ventilation in most patients.

However, sometimes peak airway pressures rise dangerously and may cause pulmonary barotrauma, damage to the airway epithelium and cardiovascular depression. These effects may be aggravated if PEEP is used.

Despite the enthusiastic support that HFV has received in the early 1980s and its potential advantages in a number of theoretical indications, this technique has been losing popularity in recent years. One of the problems in the use of prolonged HFV is poor removal of CO₂ as well as the uncomplete airway humidification. The association of HFV with CMV offers advantages of each one.

The aim of this study was to report an unusual case of ARDS—multiple organ failure (MOF) due to psittacosis treated successively with CMV/PEEP, assistant ventilation, IMV, and the superimposed HFV/CMV.

CASE REPORT

A 73-year-old man who had been treated 48 hours in the urologic service for bladder carcinoma developed the sudden onset of tachypnea, cough productive of green sputum, mental obtundation, and pyrexia (40°C). He was admitted to our intensive care unit. On admission, he was dyspneic at rest, reacted only to strong painful stimuli, was hypotensive (blood pressure 90/40 mm Hg), and oliguric. Chest roentgenogram suggested ARDS. Blood gas values were: FIO₂ 0.8; pH, 7.10; PaCO₂, 80 mm Hg; and PaO₂, 25 mm Hg. Chemical and hematologic test results were as follows: Na, 138 mEq/L; K, 3.71 mEq/L; urea, 54 mg/dl; creatinine 1.6 mg/dl; hemoglobin, 11 g/dl; and white blood cell count, 14,300/cu mm. Tracheal intubation was immediately performed, and mechanical ventilation was started as follows: FIO₂, 0.8; VT, 12 ml/kg; and a rate of 20 breaths/min. A thermodilution balloon-tipped catheter was placed in the pulmonary artery in order to obtain pulmonary pressures and CO. Conventional formulas were used for hemodynamic calculations. Pulmonary occlusion pressure (PWP) at this time was 14 mm Hg. Blood samples were collected, and continuous arterial systemic pressure was determined by a previously-inserted femoral arterial catheter. Fluid replacement with colloids and crystalloids, isotopes, diuretics, gastric protection with cimetidine, and nutritional formula were administered.

After 48 hours of CMV with "ideal" PEEP of 18 cmH₂O, the following measurements were achieved: pH, 7.27; PaCO₂, 67 mm Hg; PaO₂, 43 mm Hg (FIO₂, 0.8); and airway peak pressure, 55 cmH₂O.

Since no clinical response was observed, we superimposed HFV delivered through a solenoid valve, at a rate of 120 breaths/min to CMV. The system for HFV/CMV was previously described. One of the volumetric ventilators was replaced in this case for an electronic solenoid. Four hours later, the following data were obtained: pH, 7.36; PaCO₂, 41.6 mm Hg; PaO₂, 66 mm Hg (FIO₂, 0.5); airway peak pressure, 40 cmH₂O; and after 24 hours: pH, 7.40; PaCO₂, 41.5 mm Hg; PaO₂, 78 mm Hg (FIO₂, 0.4); residual high frequency PEEP, 4 cmH₂O; and an airway peak pressure of 38 cmH₂O (Rx 2). At this stage, the results of the psittacosis titers became available showing a rise from 1/4 to 1/4, and tetracycline therapy was commenced.

On the sixth day after admission (four days with HFV/CMV), he was connected to a CPAP-delivery system, and 24 hours later, he was weaned off the system.

Surprisingly, the eighth day, the patient developed cardiac arrest, and despite cardiopulmonary resuscitation maneuvers, died. No post-mortem examination was performed.

COMMENT

Chlamydia psittaci-related multiple organ failure is quite uncommon, although two cases have been reported recently. Its prognosis is associated with increasing age, leukopenia, renal failure, and severe hypoxia. "Delay in antibiotic therapy is inevitable since titers are available only after four days. At this stage, major therapeutic measures are centered in supportive care, especially respiratory ones. For this reason, the failure of usual respiratory techniques in achieving good oxygenation is a serious life-threatening problem which led us to develop other alternatives."

Although the superimposed HFV/CMV has been severely criticized, many authors have recently expressed their agreement with its use in order to combine the advantages of high flow/low pressure characteristics of HFV, with the facilities provided by CMV (adequate CO₂ removal, humidification, and oxygenation, in the noncompliant failing lung)."" Superimposed HFV/CMV in this patient provided cardiovascular stability, improved carbon dioxide removal, and oxygenation and lowered risk of barotrauma because of a reduction in the airway peak pressure (Fig 1).

Finally, we would like to suggest this method as another mode of ventilation for patients with respiratory insufficiency due to septic-ARDS (when the conventional mechanical
Sudden unexpected death is overwhelmingly cardiovascular in origin irrespective of the age of the patient. Asymptomatic diffuse pleural mesothelioma in a young man who had neither a known exposure to asbestos nor detectable ferruginous asbestos bodies in tissue is a sufficiently unusual clinical and pathologic encounter, but when sudden death was the initial manifestation of pleural mesothelioma in just such a patient, it must be exceptionally rare and, to our knowledge, has not been previously reported.

**CASE REPORT**

A 44-year-old, previously healthy rural man first complained of shortness of breath on the morning of his sudden, unexpected death. The ambulance was called, and the patient had a cardiac arrest shortly thereafter. He received 15 min of cardiopulmonary resuscitation (CPR) before ambulance arrival. He was transported by ambulance with CPR en route for another 20 to 25 min. He was dead on arrival at the nearest hospital emergency room and could not be revived with all further attempts of resuscitation.

The autopsy was performed 3 h later. A routine postmortem chest roentgenogram showed a large, right-sided pleural effusion and multilobulated mass in the right upper and lateral lung field (Fig 1). About 4 L of serosanguineous fluid was removed from the right pleural cavity. The right hemithorax was covered by a lobulated, firm pleural tumor, invading the chest wall and subpleural regions of the right lung and involving the regional lymph nodes and right dome of the diaphragm. There were no distant metastases. Histologically, the tumors sampled from multiple sites showed predominantly a mixed epithelial-sarcomatoid biphasic pattern of malignant mesothelioma (Fig 2). There were few foci of desmoplastic pattern. Immunohistochemically, the tumor stained negatively with carcinoembryonic antigen and vimentin, and positively with low and high molecular weight cytokeratin, epithelial membrane antigen, and human milk fat globule protein. However, no ferruginous asbestos bodies were found even after an extensive search in multiple tissue samples. There was also a fresh acute thromboembolus in the left main pulmonary artery, but no other abnormal autopsy finding.

**Sudden Death as the Initial Manifestation of Diffuse Pleural Mesothelioma**

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Malignant mesotheliomas are generally considered pathognomonic of asbestos exposure. The prognosis of mesothelioma varies with clinical staging of the disease. The overall survival of patients from the time of diagnosis is six to 16 months. Although patients with malignant mesothelioma often have nonspecific symptoms and signs, occult diffuse pleural mesothelioma is uncommon, and one that occurs in a patient with no evidence of asbestos exposure must be exceedingly rare. Sudden death as the initial manifestation of pleural mesothelioma, to our knowledge, has not been previously reported in the literature. One such unusual case is documented here. *(Chest 1999; 95:652-54)*

FIGURE 1. Ventilation-oxygenation and peak airway pressure during mechanical ventilation. Asterisk is superimposed HFV/CMV

ventilation techniques fail), and we conclude that further investigations are required to define its role in this kind of patient.

**REFERENCES**


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Sudden Death in Diffuse Pleural Mesothelioma (J. T. Lie)