Title: HIGH FREQUENCY POSITIVE PRESSURE VENTILATION FOR PROLONGED RESPIRATORY SUPPORT

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Introduction: High frequency positive pressure ventilation (HFPPV) has been used for many years in laryngeal and tracheal surgery.[1] Recently considerable interest in this form of mechanical ventilation has developed for emergency respiratory support[2] and for prolonged ventilation in respiratory failure.[3] We report our results with HFPPV in five patients with acute respiratory failure.

Material and Methods: An experimental fluidic ventilator, generously loaned by the inventors,[2] was used. With this device, inspiratory and expiratory time can be independently adjusted to obtain any desired respiratory rate and I : E ratio. Flow is determined by the driving pressure applied to the ventilator. Tidal volume depends on flow and inspiratory time. When driving pressure is 20-50 p.s.i.g. and ventilation is delivered through a 14-gauge catheter, the linear velocity of delivered gases increases enough to cause the pressure lateral to the catheter to become negative. Thus tidal volume can be increased by 20-60% by Venturi effect, if additional gas flow from a separate source is available. Patients were considered for the study if conventional respiratory support had failed to provide life-sustaining ventilation. Informed consent was obtained and the study approved by the Clinical Investigation Committee. Patient #1 had a large bronchopleural fistula and severe bilateral gram-negative pneumonia; #2 had a tracheo-esophageal fistula; #3 had a viral pneumonia and cyclophosphamide-induced lung fibrosis; #4 had post-bone marrow transplant interstitial pneumonia and multiple ruptures of pulmonary blebs; #5 had chronic obstructive pulmonary disease. Respiratory rate was adjusted in all cases at 110 breaths/minute and I:E ratio at 1:2.

Results: Duration of ventilatory support in the four patients that tolerated HFPPV was 2 days to 5 weeks (Tab. 1). Two of the patients survived, and two died. In all instances, CO_2 clearance was easily achieved and was always superior to conventional ventilation (Tab. 1). Arterial oxygenation also improved in all cases after initiation of HFPPV; hemodynamic variables were unchanged or improved if compared with conventional ventilation (Tab. 1). Positive end-expiratory pressure (PEEP) was applied as needed; peak airway pressure was 4-8 cm.H_2O. In Patient #4, peak airway pressure increased progressively to 35 cm.H_2O. Autopsy revealed almost complete occlusion of both mainstem bronchi.

Discussion: HFPPV proved a simple and flexible device for respiratory support. Its advantageous feature appeared to be the ability to provide adequate CO_2 clearance without causing significant increase in airway pressure. Furthermore, although the principles of HFPPV are not yet completely understood, lung volumes are apparently minimally affected. Inspiratory and expiratory flow are probably simultaneous and coaxial. Adequate ventilation can thus be maintained even in the presence of major disruption of the tracheobronchial structures. Pulmonary compliance and elastic recoil become relatively unimportant during HFPPV, making this form of ventilation ideal for patients with acute respiratory failure and lung fibrosis. One patient with chronic obstructive pulmonary disease was unable to tolerate HFPPV, although blood gases had improved. Irritation of the airways caused by continuous pulses of gases, possibly with incomplete humidification, may have been responsible. A mortality rate of 50% is compatible with very severe respiratory failure. It should be noted, however, that all patients had shown a progressive deterioration with conventional modes of support. Although additional investigation and improvements are necessary, there seem to be significant potential advantages for HFPPV in some forms of respiratory failure.

Reference:

1. Erikson I, Sjosstrand U: A clinical evaluation of high-frequency positive-pressure ventilation (HFPPV) in laryngoscopy under general anaesthesia. Acta Anaesth Scand 21 (Supp 64) :101-110, 1977.
2. Klain M, Brian-Smith R: High frequency percutaneous transtracheal jet ventilation. Crit Care Med 5:280-287, 1977.
3. Bjerager K, Sjostrand U, Wattival M: Long term treatment of two patients with respiratory insufficiency with IPPV/PEEP and HFPPV/PEEP. Acta Anaesth Scand 21 (Supp 64) :55-68, 1977.

Table 1

		PaO_2 (torr)		$PaCO_2$ (torr)		CI	
No.	DV	CV	HFPPV	CV	HFPPV	CV	HFPPV
1	23	48	113	85	43	3.6	4.1
2	2	67	75	81	46	4.0	4.0
3	3	51	85	60	38	1.8	3.0
4	38	37	63	78	37	3.0	4.2
5	NA	48	56	58	53	NA	NA

DV: Duration of ventilation (days)
CV: Conventional ventilation
CI: Cardiac Index (L/min/m^2)
PaO_2 was measured on FiO_2 .40.

Tab. 1. Modifications of some variables studied after conversion from conventional ventilation to HFPPV