Title: MUCOCILIARY TRANSPORT WITH AND WITHOUT HUMIDIFICATION IN HIGH FREQUENCY VENTILATION

Authors: M. Klain, M.D., U. Nordin, M.D., and H. Keszler, M.D.

Affiliation: Department of Anesthesiology and Critical Care Medicine and Department of Otolaryngology, School of Medicine, University of Pittsburgh, Pittsburgh, PA 15213

Introduction. The purpose of our study was to explore the need for humidification in high frequency jet ventilation (HFJV), and to find out how much humidity is needed to prevent impairment of mucociliary transport (MCT).

Methods. Experiments were performed on 24 mongrel dogs. Thiopental was used for anesthesia. In those that were intubated, succinylcholine was also used. In all experiments with HFJV, the IDC VS600 jet ventilator was used with 100 percent oxygen as driving gas, a rate of 120/minute with 30 percent of the cycle for inspiration and driving pressure of 1.5 to 3.5 bar. In most experiments, PCO_2 was maintained at a low normal level.

MCT was studied using cardiogreen as a marker. The transport was followed by direct observation through a Hopkins-Storz bronchoscope, and was documented by filming.

Group 1. In six spontaneously breathing anesthetized dogs, MCT was observed without humidification and without artificial airway. One dog in this group was later intubated and ventilated with HFJV without humidification.

Group 2. In five dogs, the driving gas for jet ventilation was humidified with saline at a rate of 0.6 - 3.1 cc/kg/hour without, however, humidifying the entrained air.

Group 3. In thirteen experiments, both the driving gas and the entrained gas were humidified. Saline at a rate of 1.1 to 3.0 cc/kg/hour was utilized for the driving gas. A nebulizer was used for the entrained gas. The tube was a standard endotracheal tube #9 with a 14g catheter needle inside used for jet ventilation.

Results. In spontaneously breathing dogs, the transportation speed was around one centimeter per minute in the trachea.

In the dog ventilated with HFJV without humidification after only a few minutes of ventilation absolutely no transport could be seen. After two hours of ventilation, the mucosa seemed completely dried out.

In the experiments where the entrained gas was not humidified only very slow or no transportation was observed. When both the jet gas and the entrained gas were humidified, the mucociliary transport was preserved.

As the weight of the dogs varied considerably, we chose to relate the amount of saline added to the body weight of the dog.

We were then able to show that 1.1 cc/hr of saline per kg of body weight preserved MCT even if the driving pressure of the ventilator was doubled.

If too much saline (more than 2 cc/kg/hour) was added to the jet stream the mucosa seemed very swollen and MCT deteriorated. The blood gases also deteriorated.

Conclusions. Our results confirmed the great importance of humidification during high frequency ventilation in order to preserve the mucociliary transport. Both unsufficient or too much humidity is harmful resulting in impairment of mucociliary transport.

Although we achieved good MCT without warming the humidified mixture, there can be little doubt that warming is highly desirable in order to avoid heat loss.