SUPPORT OF SPONTANEOUS BREATHING DURING HIGH-FREQUENCY OSCILLATORY VENTILATION

Motivation:

High-frequency oscillatory ventilation (HFOV) is a protective method of mechanical ventilation: High ventilatory frequencies and small tidal volumes used during the ventilation imply low changes in pressure in the airways. HFOV thus reduces mechanical damage to a patient's lungs which occurs frequently when conventional modes of mechanical ventilation are used.

Preservation of spontaneous breathing during HFOV is beneficial as it improves oxygenation, reduces need of sedation of a patient and shortens the time of a patient's ICU stay. However, spontaneous breathing during HFOV is not well tolerated by the ventilator: A patient's respiratory effort (work of breathing) raises, and high changes in pressure inside the ventilator circuit can even stop functioning of the ventilator.

Aim:

To create a device, called the Demand Flow System (DFS), which facilitates spontaneous breathing of a patient during high-frequency oscillatory ventilation without impeding function of the high-frequency mechanical ventilator and which decreases a patient's work of breathing.

Methods:

The DFS automatically compensates for the changes of gas volume inside the ventilator circuit caused by a patient's spontaneous breathing. The DFS evaluates the change in pressure related to the gas volume decrease during a patient's inhalation or its increase during a patient's exhalation. A regulator controls the inflow of gas into the ventilator circuit (Fig. 1), so that the mean pressure in the circuit at a patient's airway opening remains unaltered.

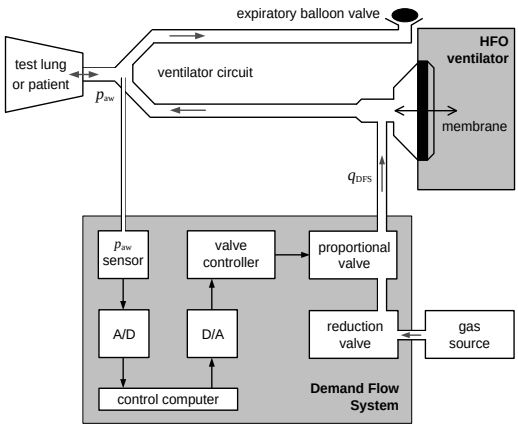

Fig. 1: The structure of the Demand Flow System.

Results:

Simulations show the ability of the DFS to maintain the constant mean pressure in the ventilator circuit and in the airways during a patient's spontaneous breathing (Fig. 2). Animal experiments prove reduction in work of breathing with DFS in use.

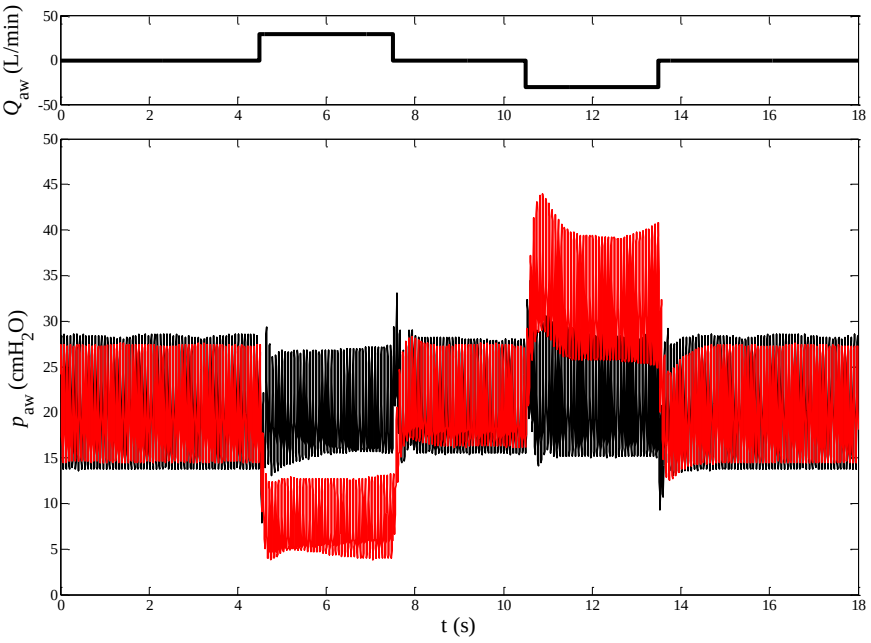

Fig. 2: Pressure measured at the airway opening (lower picture) during simulated spontaneous breathing flow (upper picture). Pressure signal was measured with the DFS regulator deactivated (red) and activated (black).

Conclusions:

The designed Demand Flow System facilitates spontaneous breathing of a patient during high-frequency oscillatory ventilation, and may contribute to a better utilization of the protective method of mechanical ventilation in clinical care.

Publications:

VAN HEERDE, M., ROUBIK, K., KOPELENT, V., PLÖTZ, B., and MARKOHORST, D. Unloading work of breathing during high-frequency oscillatory ventilation: a bench study. *Critical Care*, 2006, vol. 10, no. 4, R103. ISSN 1364-8535.

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VAN HEERDE, M., ROUBIK, K., KOPELENT, V., KNEYBER, M. C. J., and MARKHORST, D. Spontaneous breathing during high-frequency oscillatory ventilation improves regional lung characteristics in experimental lung injury. *Acta Anaesthesiologica Scandinavica*, November 2010, vol. 54, no. 10, p. 1248-1256. pISSN 0001-5172, eISSN 1399-6576.

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