Effective flow rates and decarboxylation differs between nasal high-flow devices

Jens Bräunlich, Hubert Wirtz, University of Leipzig Germany

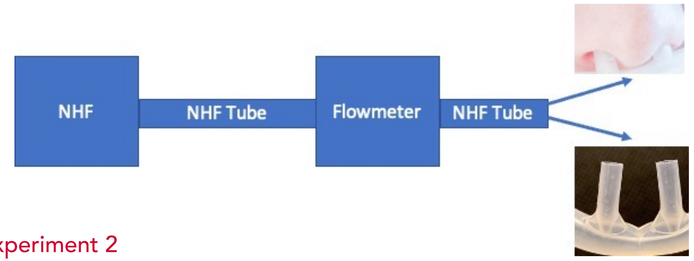
Introduction

Different study results in hypercapnic respiratory failure leads to inconclusive implications regarding the use of NHF in this patient group. Flow rate influences directly the elimination of CO2 in the blood. Therefor insufficient flow rates influence study results, especially in case of hypercapnia.

Methods

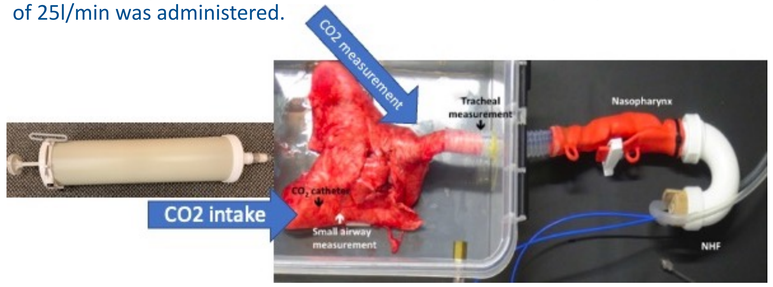
Experiment 1

We measured the effective flow rate with a preset flow rate of 20l/min of two turbine-driven NHF devices with a flowmeter. The measurements were performed with the tube without placement in the nose or with placement in the nose to take into account nasal resistance as well.



Experiment 2

In the second experiment we measured the elimination of CO2 in a physiological lung model. CO2 was inserted through a catheter in the distal airways. The concentration of CO2 (ppm) was measured in the distal trachea via a catheter. The sheep lung was ventilated with different respiratory rates (15-30 l/min) and tidal volumes (300,700 ml). After achieve a steady state (CO2) NHF with a flow of 25l/min was administered.



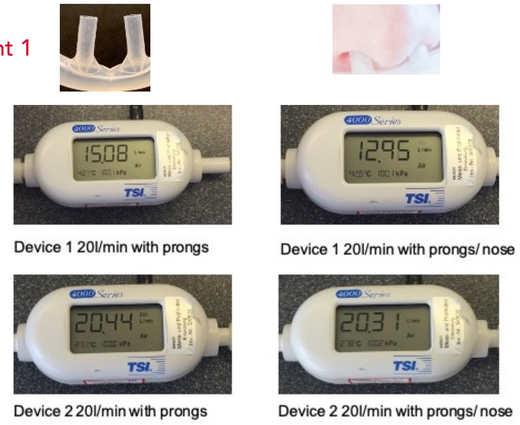
Main Finding

In our comparison of the effective flow rate of two devices regarding the CO2 removal in a ventilated sheep lung we found significant differences. The difference between the devices was stronger in higher tidal volume.

Our data suggests that there may be a clinical important difference in turbine driven NHF devices. These could explain different study results especially regarding decarboxylation.

Results

Experiment 1



Device 1 20l/min with prongs

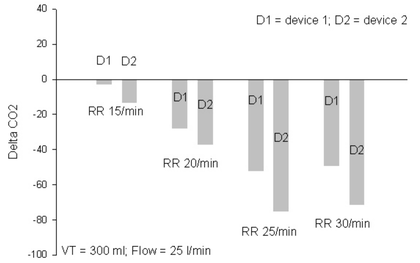
Device 1 20l/min with prongs/ nose

Device 2 20l/min with prongs

Device 2 20l/min with prongs/ nose

Below 20l min flow, we found a clear deviation of the measured flow from the set flow (device 1). By inserting the prongs into the nose, the difference became even more pronounced (+ nasal resistance). In device 2, the set flow was stable in both settings

Experiment 2



When testing the devices in the ventilated sheep lung, clear differences became apparent. With a tidal volume of 300 ml, device 1 was inferior to device 2 in terms of CO2 reduction at all breathing rates.

The test with 700 ml tidal volume showed an even clearer result. There was even an increase in CO2 at lower breathing rates under device 1. The washout effectiveness of device 2 was similar under both tidal volumes.