

NEW WAY OF HELIOX ADMINISTRATION IN RESPIRATORY CARE

Motivation: Chronic obstructive pulmonary disease belongs to the worldwide considerable causes of mortality and chronic morbidity. Currently, it is the fourth most frequent cause of death in the World. Therapy outcomes of these patients are disappointing; spontaneous ventilation often fails and noninvasive or mechanical ventilation should be initiated. A limiting factor for using heliox in clinical practice is its high cost. Heliox is applied by using an open circuit.

Aim: The aim of the study is to design and test a semi-closed rebreathing circuit for heliox application in order to minimize consumption of helium and, therefore, reduce the expensiveness of spontaneous breathing with heliox.

Methods: The study is conducted at the Department of Anaesthesiology and Resuscitation at Thomayer University Hospital in Prague. The designed semi-closed circuit is tested in combination with spontaneous breathing in healthy volunteers. The measured parameters of expired gas are recorded by Spirometer ZAN 600 (nSpire Health, Inc., Germany), measurement system Chimaera (FBMI CTU, Czech Republic) and by multimodal monitor S/5 (Datex-Ohmeda, Germany). Esophageal pressure is measured by oesophageal balloon probe (Hamilton Medical, Switzerland). Respiratory effort is assessed by calculation of pressure time product (PTP), and the resistive work of breathing (WOB), further by evaluating of the end-tidal fraction of O₂ (FO_{2et}) and CO₂ (FCO_{2et}). The performed pilot study is divided into four ventilation phases, each with a length of 10 minutes (see Table 1).

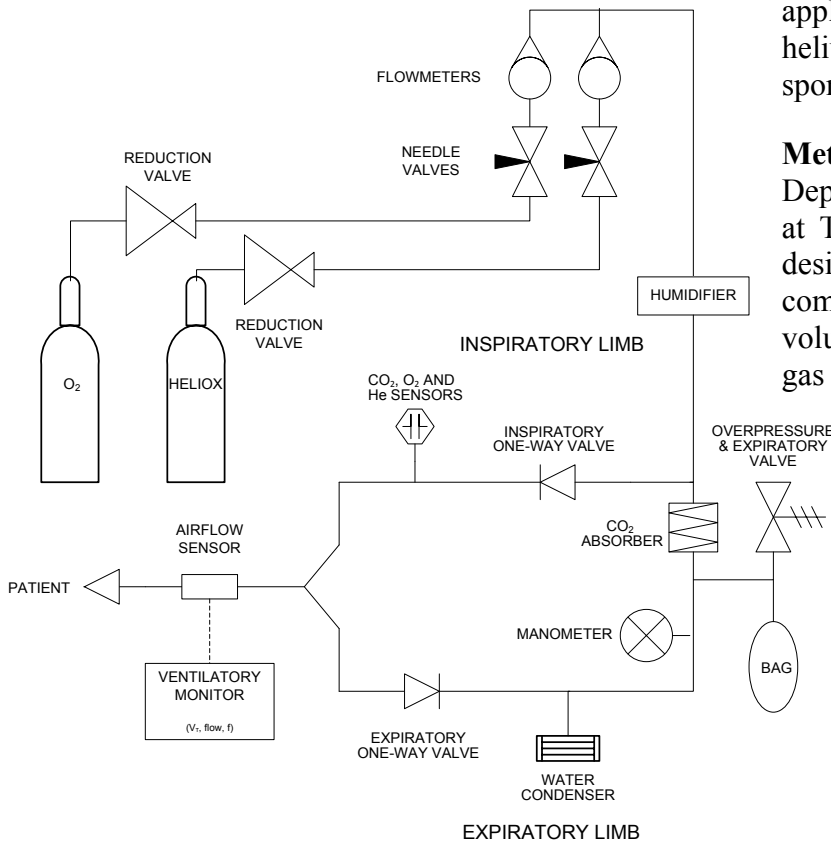


Fig. 1: Scheme of designed semi-closed circuit.

Results: Evaluation of the semi-closed circuit in a group of healthy volunteers is ongoing; the preliminary results (n = 7) are presented in Table 2.

The main finding of this study is that replacing air with heliox during noninvasive ventilation administered by using the semi-closed system in healthy volunteers does not significantly increase PTP (see Fig. 2), WOB (see Fig. 3) and FCO_{2et} compared with an open circuit and thus we expect its effect in patients with COPD.

Tab. 1: Phases of Measurement of Work of Breathing in Healthy Volunteers.

Ph.	Ventilatory circuit	Ventilatory mixture	Fresh gas flow (Q _{fgf})
1	One-way system – face mask with Ayre T	Air	20 l/min
2	One-way system – face mask with Ayre T	heliox 79:21	20 l/min
3	Semi-closed circuit	Air	3 l/min
4	Semi-closed circuit	heliox 79:21	3 l/min

Tab. 2: Preliminary results (n = 7) of inspiratory pressure time product (PTP₁), inspiratory work of breathing (WOB₁), end-tidal fraction of O₂ (FO_{2et}) and CO₂ (FCO_{2et})

Measured parameter	Phase 1	Phase 2	Phase 3	Phase 4
PTP ₁ (cmH ₂ O.s/min)	130.58 ± 102.29	133.43 ± 108.64	161.02 ± 77.28	118.83 ± 83.92
WOB ₁ (J/l)	2.56 ± 1.99	2.78 ± 2.07	3.31 ± 1.55	2.38 ± 1.73
FO _{2et} (%)	6.29 ± 1.87	7.24 ± 2.20	5.76 ± 2.60	8.79 ± 0.70
FCO _{2et} (%)	4.86 ± 1.20	4.36 ± 1.27	5.39 ± 0.34	4.98 ± 0.27

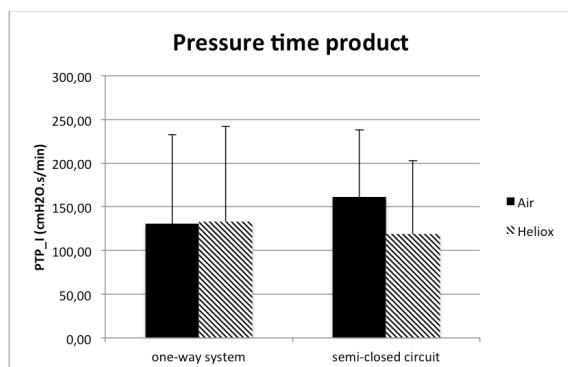


Fig. 2: Inspiratory PTP for one-way system and for semi-closed circuit in the 7 patients. Values are mean \pm SD.

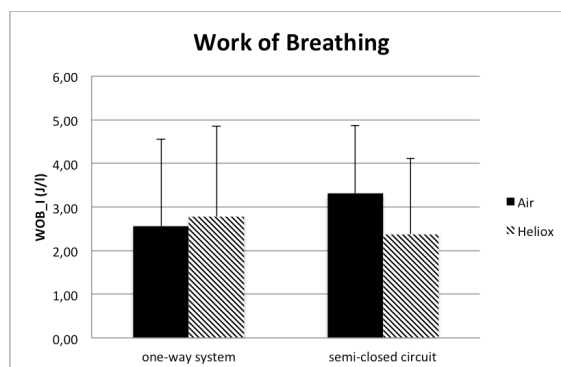


Fig. 3: Inspiratory WOB for one-way system and for semi-closed circuit in the 7 patients. Values are mean \pm SD.

Conclusion: Use of the semi-closed rebreathing circuit offers a potential benefit of heliox in patients with obstructive bronchopulmonary diseases at a lower cost than during heliox application using an open circuit. The designed semi-closed circuit reduces the work of breathing in healthy volunteers, it was confirmed by results from the pilot study. The designed semi-closed circuit for noninvasive ventilation with heliox can offer a cost effective heliox application in acute asthma or COPD exacerbation patients.

Publication:

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STRNADOVÁ, A., ROUBÍK, K., ZAZULA, R., SPÁLENÝ, A., MÜLLER, M., et al. *Spontaneous Breathing of Heliox Using a Semi-Closed Circuit Reduces Expensiveness of Ventilation While Preserving the Positive Heliox Effects: A Bench Study* In: Physiological Research. 2010, vol. 59, no. 5, p. 42P-43P. ISSN 0862-8408.

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