Reviewer’s report

Title: Bench Experiments Comparing Simulated Inspiratory Effort when Breathing Helium-Oxygen Mixtures to that during Positive Pressure Support with Air

Version: 1 Date: 16 May 2012

Reviewer: Tomasz Golczewski

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Developing of methods supporting patients suffering from obstructive diseases is of high significance since these diseases star to be the 3rd cause of death in developed countries. The manuscript is related to two of such methods.

The authors proved experimentally that if the resistance of a pneumatic resistor depends on gas density, then this resistance depends on this density; however, if the resistance does not depend on the density, then this resistance does not depend on this density [unless Reynold’s number is greater]. It would be a nice experiment in the secondary school.

Additionally, the authors showed that if two ventilators realize the same task, then if one ventilator works more intensively then the other one can work less intensively.

Concluding these general comments: the manuscript might be treated [after shortening] as a popular article on the important subject; an article illustrated with data from authors’ experiments.

Major Comments

Bronchi are collapsible: more (smaller bronchi) or less (larger ones, as the trachea, for example). Their collapse play the main role in patients suffering from obstructive lung diseases. Thus, neither linear resistors nor nonlinear but constant ones can accurately simulate bronchi in such patients. Hence, the described experiments can be treated only as a general illustration of gas flow through tubes; they cannot be treated as true simulations of gas flow in bronchi.

Expiratory flow limitation appearing during tidal breathing is the fundamental base of troubles with breathing in obstructive diseases, esp. in severe obstruction [only such obstruction requires a physical support]. It is almost commonly accepted now that this limitation is related to the Bernoulli’s principle [the Dawson’s and Elliot’s wave-speed criterion]. The gas density plays the fundamental role in this principle, and the efficacy of He/O2 seems to be mainly connected with the principle; turbulent flow in [severe] obstruction is rather meaningless because of low values of possible maximal flow [the result of flow limitation].

The authors do not take into account and discuss the Bernoulli’s principle at all.
The authors stated that they analyzed the inspiratory effort for obstructions of various severity and location but they treated higher resistance as the synonym for obstruction, which is not true. For example, rat’s airway resistance is much higher than for healthy human being but it does not mean that rats have very, very severe obstruction. In fact, the obstructive disease is a lack of correspondence between the lungs size [usually estimated with the (forced) vital capacity] and a kind of bronchial airflow capacity [now quantified by means of the forced expiratory volume in one second (or by peak maximal flow for obstruction in upper airways or large bronchi)].

The manuscript would be much better if the authors simulated true obstructions [a reliable bronchi model + a reliable lung model]. Now it is only an illustration of well-known dependence of resistance on gas density during turbulent flow.

Minor Essential Comments
The manuscript, esp. the Methods part, is written very badly. ‘Methods’ should be divided into sub-parts:
- ‘Artificial patient’ [or another sub-title] - Presentation of the equipment that simulates the patient: in particular, how both chambers moved [expanded] and interact, whether their compliance (or one of them) corresponds to the lung compliance or to the total compliance (lungs and the chest wall as well abdomen), how springs work [how they change compliance], etc. Such a concise description would enable to better assess how accurately the real patient is simulated by the equipment,
- ‘Simulation procedures’ – Now, the patient description and presentation of the procedures are mixed which makes reading very difficult [some procedures and more detailed explanations of the patient appear in the Discussion part].
- ‘Data analysis’ – how everything is calculated [mathematical equations would be more convenient than verbose but not clear description in words].

There are many editorial mistakes [so many authors - one could read carefully the manuscript before sending], for example:
- The authors wrote: “Figures 4 compares the relative influences of the resistive loss coefficient, level of pressure support, administered gas, and breathing pattern on inspiratory effort.” – I cannot see this in fig.4 [a mistake in the figure number – perhaps should be fig.3 instead of fig.4]
- What is “obstruction loss coefficient” [ fig. 4 caption] ?
- Where is fig.6? [again a mistake in figure numbering?]

Discretionary Comments
#P is ‘pressure drop’ rather than ‘pressure loss’ (#P is the drop caused by the loss)
I realize that medical doctors do not like mathematical equations but some mathematical formulas should be presented, e.g. ones that explain
mathematically the correction of the work done [despite that I have read the Methods sever times, I am not sure whether I understand the correction method]. Such mathematical description could be added as the Appendix if the authors avoid MDs.

It would be interesting to explain why the inspiratory effort extrapolated for resistance equal to zero is different for air and He/O2.

**Level of interest:** An article of insufficient interest to warrant publication in a scientific/medical journal

**Quality of written English:** Acceptable

**Statistical review:** No, the manuscript does not need to be seen by a statistician.

**Declaration of competing interests:**

I declare that I have no competing interests