

## Population-based parameterization of the oxygen input function (OIF) for dynamic oxygen-enhanced MRI

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**TARGET AUDIENCE:** Clinicians and scientists involved in developing Oxygen Enhanced-MRI (OE-MRI) techniques and performing OE-MRI studies, either clinically or pre-clinically.

**PURPOSE:** To characterize the respiratory input function by measuring the amount of inspired oxygen in subjects using two different types of standard clinical masks. When performing oxygen-enhanced MRI, an oxygen input function (OIF) characterizing the amount of inspired oxygen is required to allow standardized parameterization of changes in  $T_1$  contrast due to the switch from breathing air to pure oxygen and vice versa<sup>1</sup>. A step function has been used in previous studies<sup>2</sup> as an approximation of the OIF for OE-MRI. In this work, we derived a population-based parameterization of the OIF from direct measurements of the oxygen concentration in two different standard clinical masks.

**METHODS:** Oxygen level readings were obtained from repeated measurements in 32 subjects while being scanned as part of a larger OE-MRI study<sup>3</sup> (n=110 dataset). Oxygen levels were measured with a gas analyzer (ML206,

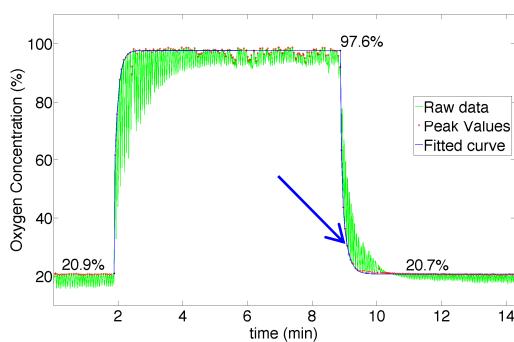


Figure 1: Example of the OIF parameterization (blue line) to the inspired oxygen, defined by the peaks (red circles) of the oxygen concentration reading (green line). Note that during wash-out, the lowest points of the curve define the inspired oxygen (blue arrow), given the reversal of oxygen concentration gradient.

breathing period was compared for both masks via an unpaired t-test.

Wash-in was characterized by a bi-exponential function of the form:  $A_1 * (1 - \exp(-t/\alpha_1)) + A_2 * (1 - \exp(-t/\alpha_2)) + C$  and wash-out, by a bi-exponential decay function of the form:  $B_1 * \exp(-t/\beta_1) + B_2 * \exp(-t/\beta_2) + D$ .

**RESULTS:** Figure 1 shows an example of the OIF derived from the amount of inspired oxygen. Figure 2 shows the

parameterized OIF derived from the median of all dataset along with the fitting results for each dataset. Figure 3 shows the oxygen plateau for each type of mask. The difference of the means is significant ( $p=0.003$ ) but small enough ( $< 2\%$ ) not to make a material difference to the group parameterization of the OIF.

**CONCLUSIONS:** We have presented a parameterized OIF for analysis of OEMRI data acquired using standard clinical high concentration oxygen

masks. While small differences are observed between different gas delivery masks, the results suggest a population-based OIF provides an adequate description of the true OIF at the individual level and it can be used instead of a step function when modeling OE-MRI data.

**REFERENCES:** [1] McGrath D. et al., MRI 26: 221–227; 2008. [2] Rose C. et al., Proc. Intl. Soc. Mag. Reson. Med. 19: 0928; 2011. [3] Zhang W. et al., Eur. Respir. J. 42(Suppl. 57): 3028; 2013.

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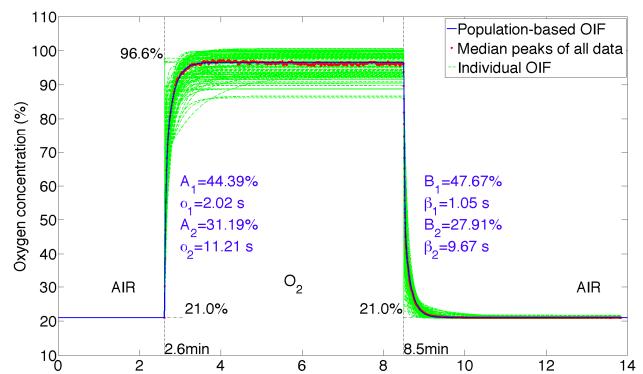


Figure 2: Parameterized OIF (blue line) derived from the median over-the-data inspired oxygen (red dots) and OIF for each individual dataset (green lines). See the main text for details.

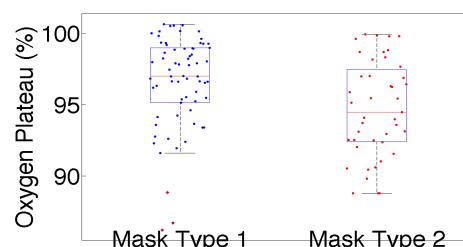


Figure 3: Oxygen plateau for each type of mask. Difference in mean are statistically significant ( $p=0.003$ ), but the actual difference between groups is less than 2%.