

# 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<sub>1</sub> 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,

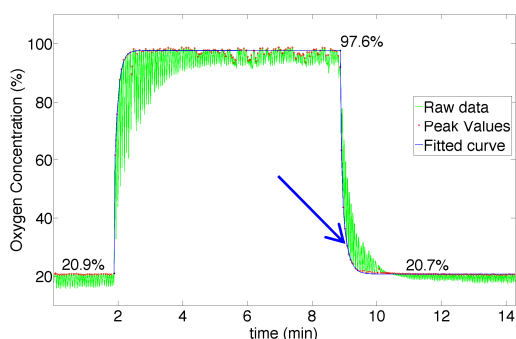


Figure 1: Example of the OIF parameterization (blue line) to the inspired oxygen, defined by the peaks (red circles) of the oxygen concentration reading (green line). Note that during wash-out, the lowest points of the curve define the inspired oxygen (blue arrow), given the reversal of oxygen concentration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

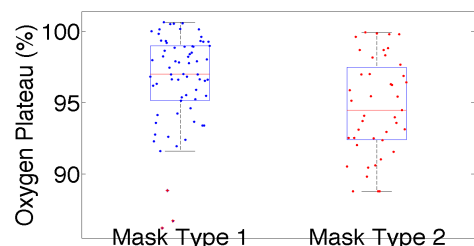


Figure 3: Oxygen plateau for each type of mask. Difference in mean are statistically significant (p=0.003), but the actual difference between groups is less than 2%

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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ADInstruments, Oxford, UK) inserted directly into two different types of standard clinical masks (high concentration disposable masks with oxygen tube and reservoir, Intersurgical, Berkshire, UK). Gas was delivered at 15L/min from compressed gas cylinders. The switching between air and 100% oxygen and vice versa was done manually using a flow meter within 5 seconds. Data analysis and curve fitting were performed in MATLAB (2013b, The Mathworks, Natick, MA, USA).

The amount of inspired oxygen was defined as the peaks of each breathing cycle, except during wash-out, where it was defined as the lowest point, given the reversal of the oxygen concentration gradient when switching from 100% to 21% (Figure 1). The amount of inspired oxygen during the 100% oxygen-

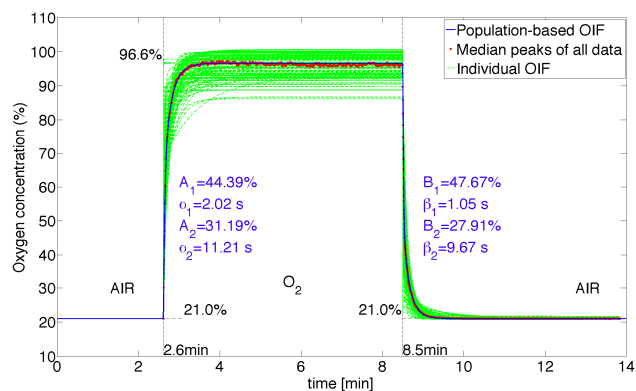


Figure 2: Parameterized OIF (blue line) derived from the median over-the-data inspired oxygen (red dots) and OIF for each individual dataset (green lines). See the main text for details.