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# A New Formula for Predicting the Fraction of Delivered Oxygen During Low-Flow Oxygen Therapy

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## Abstract

**BACKGROUND:** During $O_2$ therapy at low flow in patients who breathe spontaneously, the fraction of delivered $O_2$ ($F_{DO_2}$) is unknown. In recent years, $F_{DO_2}$ prediction formulas have been proposed. However, they do not take into account the effect of inspiratory flow ($\dot{V}_I$) on the $F_{DO_2}$. The aim of this study was to validate a new $F_{DO_2}$ prediction formula, which takes into account the $\dot{V}_I$ and compares it with other $F_{DO_2}$ prediction formulas.

**METHODS:** During a bench study, spontaneous breathing was generated with a mechanical test lung connected to a mechanical ventilator set to volume control mode. $O_2$ flow from a wall-mounted tube was delivered through a heat-and-moisture exchanger filter. A flow sensor recorded each breath of the $\dot{V}_I$ in ambient temperature and barometric pressure conditions. Three parameters [$O_2$ flow at 2, 3, 4, 5, 6 L/min; minute ventilation at 5, 10, 15, 20 L/min; and ratio of the inspiratory time ($T_I$) to the total breathing cycle time ($T_{tot}$) ($T_I/T_{tot}$) of 0.33 ($T_I/T_{tot}$ value) and 0.50 ($T_I/T_{tot}$ value)] were modified to generate many ventilatory patterns. An $O_2$ analyzer continuously examined the $F_{DO_2}$.

**RESULTS:** When the $O_2$ flow and/or $T_I/T_{tot}$ increased, the $F_{DO_2}$ increased. When the minute ventilation increased, the $F_{DO_2}$ decreased. The results of the Bland-Altman method for the $F_{DO_2}$, calculated by using our mathematical model and the measured $F_{DO_2}$, showed that the mean ± SD bias value was equal to 1.49 ± 0.84%, and the limits of agreement ranged from

−0.17% to 3.14%. The intraclass correlation coefficients were 0.991 for $T_I/T_{tot}$ = 0.33 and 0.994 for $T_I/T_{tot}$ = 0.50, and the coefficient of variation was 2.1% for $T_I/T_{tot}$ = 0.33 and 1.3% for $T_I/T_{tot}$ = 0.50. The results of the Bland-Altman method for the $F_{DO_2}$ calculated by using the Shapiro formula and the $F_{DO_2}$ measured on the bench indicated that the bias value was 0.075 ± 8.66% and the limits of agreement ranged from −16.89% to 17.04%. For the Vincent formula, the bias value was 3.08% ± 8.56% and the limits of agreement ranged from −13.69% to 19.84%.

**CONCLUSIONS:** The $\dot{V}_I$ has a major impact on $F_{DO_2}$ during $O_2$ therapy at low flow. $F_{DO_2}$ comparisons between frequently used prediction formulas and $F_{DO_2}$ measured on the bench indicated greater differences. Uncritical use of these formulas should be used cautiously to predict $F_{DO_2}$. In this study, our prediction formula indicated a good accuracy for predicting $F_{DO_2}$ during supplemental oxygenation through a heat-and-moisture exchanger in patients who breathe spontaneously.

oxygen $F_{DO_2}$ low flow oxygen therapy prediction formula

## Footnotes

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- The authors have disclosed no conflicts of interest.
- Supplementary material related to this paper is available at http://www.rcjournal.com.



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