more efficient with NOC than NC. The differences of FDO2 between NOC and NC decrease with increasing MV. The FDO2 fluctuations according to the value of the MV are greater with the NOC to 4 L/min. In clinical situation, NOC is less used than the NC. Compared to the NC, NOC is an alternative to increase the FDO2 with the same OFR. NOC is more efficient than NC because during expiratory time, anatomical dead space it fills with O_2, which increases the FDO2. However, if the respiratory frequency increases then expiratory time decreases, filling with O_2 decreases which reduces FDO2. Note that NOC may become uncomfortable at OFR greater than 5 L/min.

Competing interests
None.

Reference

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Variability of fractional delivered oxygen (FDO2) with nasal cannula

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Introduction Nasal Cannula (NC) is an option to deliver oxygen therapy. According to American Thoracic Society (ATS), standard NC delivers a fractional delivered oxygen (FDO2) of 24–40% at supply oxygen flows ranging from 1 to 5 L/min. An equation was proposed by ATS to predict oxygen delivery: FDO2 = 20% + (4 * O2 L/min). Moreover, for ATS, FDO2 is also influenced by respiratory frequency (Rf), tidal volume (Vt) and ratio Ti/Ttot. However, the equation of ATS does not take into account these parameters. Our hypothesis is that these parameters can significantly affect the FDO2. The aim of this study was to determine the effect of Rf, Vt and Ti/Ttot on FDO2.

Materials and methods The study was conducted on bench with NC connected to a two compartment adult lung model (Dual Test Lung®) (DTL) controlled by a Maquet Servo I® ventilator. One oxygen flow rate (OFR) (5 L/min) and 3 min ventilation (MV: 6/9/12 L/min) with two Ti/Ttot (0.33 and 0.25) were investigated. All settings of MV were generated by modifying Rf (10–40 CPM) and Vt (0.3 and 0.6 L). Inspiratory flows rate (IFR) obtained with settings range from 18 to 48 L/min. OFR was analyzed by a thermal mass flow meter Vogtlyn™ Red Y. FDO2 and MV measurements were made using a iWorx® acquisition system (GA207 gas analyzer) and LabScribe II® software. Compliance of DTL was set to: 0.07 L/cmH_2O and resistance to: 5 $cmH_2O/L\ s^{-1}$. Statistical: ANOVA repeated measures followed by Newman Keuls method.

Results FDO2comparisons between: Ti/Ttot 0.33 and 0.25 and three MV: 6–9–12 L/min at OFR: 5 L/min.

Conclusion IFR and OFR are the main determinants of FDO2. Equation of ATS is correct when IFR is equal to 18 L/min.
When IFR is different of this value, Equation of ATS is not appropriate.
In our experiment, with an OFR of 5L/min, when IFR = 18 L/min (MV = 6 L/min and Ti/Ttot = 0.33), the FDO2 is equal to 41% (±1%) (see Table 5). To this value of IFR, the FDO2 is in accordance with the formula of ATS, but when IFR increase beyond 18 L/min, the FDO2 decrease and the formula is not in accordance with ATS. This can be explain because during inspiratory phase, air room (Fractional oxygen = 0.21) entry in airway mixes with OFR (FO2 = 1), which modifies the FDO2. In this case, when IFR increase then FDO2 decrease and vice versa. Medical and paramedical staff must be aware that with patients who receive OFR by nasal cannula, any change of OFR and/or inspiratory flow changes the FDO2. In this case, for maintain the same FDO2, it is necessary that modify the value of OFR.

Competing interests
None.

Reference

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Table 5 FDO2 comparisons between diffferent TI/Ttot and MV at OFR 5 L/min

MV (L/min)	Ti/Ttot = 0.33				Ti/Ttot = 0.25			
	RfxVt	FDO2	RfxVt	FDO2	RfxVt	FDO2	RfxVt	FDO2
6	10 × 0.6	41% (a)	20 × 0.3	42% (d)	10 × 0.6	36% (g)	20 × 0.3	37% (j)
9	15 × 0.6	36% (b)	30 × 0.3	35% (e)	15 × 0.6	32% (h)	30 × 0.3	32% (k)
12	20 × 0.6	31% (c)	40 × 0.3	30% (f)	20 × 0.6	30% (i)	40 × 0.3	29% (l)

Rf respiratory frequency (in CPM), *Vt* tidal volume (in Liter)

ANOVA RM results: $p < 0.05$. No statistical difference are found between: (a–d)/(b–e)/(c–f)/(g–j)/(h–k)/(i–l)/(b–j)/(b–g)/(f–k)/(c–k)/(f–h)/(f–l)/(f–i)/(c–i)/(c–l)/(e–g)

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How to assess FiO_2 delivered under oxygen mask in clinical practice?

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Introduction The actual FiO_2delivered under oxygen mask in patients with acute respiratory failure and the factors that may influence the FiO_2 are poorly known. In clinical practice, different methods including formula or conversion tables based on oxygen flow can be used to estimate delivered FiO_2. We aimed to assess first the factors influencing measured values of FiO_2, and second the best method to estimate FiO_2 in patients breathing under oxygen mask.

Patients and methods We included ICU patients admitted for acute hypoxemic respiratory failure from a previous prospective trial [1] in whom FiO_2 was measured under oxygen mask using a portable oxygen analyzer. We collected demographic variables and respiratory parameters that may influence measured FiO_2. Low FiO_2 was defined according to the median measured FiO_2.
For each patient, measured FiO_2 was compared to "Calc + 3%" formula (FiO_2 = oxygen flow in liters per minute × 0.03 + 0.21) to "Calc + 4%" formula (FiO_2 = oxygen flow in liters per minute × 0.04 + 0.21), and to a conversion table [2]. A ± 10% limit of agreement for each estimation method was arbitrarily considered acceptable.

Results Among the 265 patients included, median measured FiO_2 was 65% [60–73]. After adjustment on oxygen flow, the three variables independently associated with low measured FiO_2 using multivariate analysis were patient's height, a low $PaCO_2$, and a respiratory rate greater than 30 breaths/min.
Using paired analysis, each estimation methods differed significantly from measured FiO_2 ($p < 0.0001$ for each). Values outside the limits