A714 - Apnea oxygenation: a novel respiratory system model for physiological studies using high-flow nasal cannula oxygen therapy

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Introduction:
Since the advent of high-flow nasal cannula (HFNC) oxygen therapy, apnea oxygenation has once again been the subject of numerous clinical studies whose results are conflicting. The physiological bases of this age-old concept, more recently applied to endotracheal intubation, have never been confirmed by current methods. We therefore decided to study the effects of an apnea oxygenation period under HFNC oxygen therapy by means of a novel modelization of the respiratory system.

Methods:
Firstly, an airway model was built with anatomical, physical and physiological attributes similar to that of a healthy subject (Fig. 1). This system reproduces the physiological evolution of intrapulmonary gases during apnea by progressively increasing CO₂ levels after having cut off previous O₂ supplies (FIO₂ 21%). Secondly, the effects of a HFNC apnea oxygenation of 50l/min with an FIO₂ of 100% were analyzed by collecting intrapulmonary gas samples at regular intervals (Fig. 2).

Results:
After 1 minute of apnea oxygenation, intrapulmonary oxygen levels remain stable at 21%. After 5 minutes, oxygen fraction reaches 33%, and increases up to 45% in 10 minutes. Regarding CO₂ levels, no significant modifications were observed.

Conclusion:
A novel experimental and physiological model of the respiratory system has been developed and confirms the existence of an alveolar oxygen supply as well as the lack of a CO₂ washout during HFNC apnea oxygenation. However, these effects are only observed after a delay of about 1.5 to 2 minutes. Therefore, the clinical interests of this technique to reduce apnea-induced desaturation during intubation of a hypoxemic patient in the ICU seem limited without adequate preoxygenation. Combination of both preoxygenation and apnea oxygenation by HFNC can most likely explain positive results observed in other clinical studies.

Image 1:
**Fig 1.** Respiratory system model

VC 4.6 l  
RV 400 ml  
$R_{aw}$ 5.6 mbar/l/s  
$C_{rs}$ 144 ml/mbar

HFNC  
50l/min $FiO2$ 100%

**Image 2:**

**Fig 2.** Evolution of intrapulmonary gases during apnea; HFNC: high-flow nasal cannula