Optimizing preoxygenation prior to tracheal intubation

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To the Editor,

The continuing professional development article by Drs. Tanoubi, Drolet, and Donati regarding optimizing preoxygenation addresses a very important aspect of anesthesia.¹

Unfortunately, their explanation of the related respiratory physiology overlooks one important point. The alveolar fraction of oxygen is diluted not only by the alveolar CO₂ but also by the saturated water vapor. Even with complete denitrogenation, there is about an 87 mmHg dilution (PaCO₂ 40 mmHg and saturated water vapor pressure 47 mmHg at 37°C). Thus, even ideally, the end-tidal O₂ is not more than about 89%.

Competing interests None declared.

Reference

1. Tanoubi I, Drolet P, Donati F. Optimizing preoxygenation in adults. *Can J Anesth* 2009; 56: 449–66.

Reply

We sincerely thank Professor Russell for his interesting comment regarding our recent publication.¹ We agree that alveolar gas is saturated with water vapor, which occupies approximately 6% of its volume, and that this phenomenon also occurs during preoxygenation. Therefore, with a carbon dioxide fraction of 5%, the theoretical limit for

end-tidal oxygen fraction (EtO₂) is 89%. This has two consequences. First, the volume of oxygen reserves calculated in our article should be decreased by 6%,¹ and the estimated apnea times without desaturation should be reduced accordingly. However, the impact of this correction is relatively minor considering that the values quoted for functional residual capacity are approximations with wide interindividual variations.

The second consequence has to do with the target oxygen fraction for adequate preoxygenation. Although the maximum value for EtO₂ is 89% if vapor pressure is taken into account, values >90% and, in some cases, >95% have been reported in various clinical settings.^{2–4} This has prompted recommendations that EtO₂ values >90% should be sought to assure optimal preoxygenation. These high values can be explained by what happens to alveolar gas before being analyzed. First, its temperature decreases when it reaches the face mask, circuit, and sample tubing, leading to condensation of water droplets and a reduction in water vapor content. At 22°C, water vapor pressure is 20 mmHg, and it cannot account for more than 2.6% of the total mixture. Also, gas analyzers are prone to malfunction in the presence of moisture, so they are supplied with devices, such as water traps, desiccators, and/or cooling systems designed to remove as much water as possible. In the end, the gas mixture that is analyzed is essentially dry allowing expired O₂ fractions well above 90%. The effect of water vapor pressure on EtO₂ measurements was not discussed in any of the articles that we reviewed. We suggest that authors of future studies should describe how water vapor influences the performance of the analyzer they use as part of a rigorous approach to the problem. A similar plea⁵ was made in the past for accurate measurement of expired CO₂ partial pressure.

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