Letters

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Methemoglobinemia and Pulse Oximetry

In reviewing the article "Methemoglobinemia: Sudden Dyspnea and Oxygen Desaturation After Esophagoduodenoscopy," in the August 2004 issue of RESPIRATORY CARE,[1] I found the article suggested that, during the esophagoduodenoscopy procedure the patient's blood oxygen saturation (measured via pulse oximetry) began to drop rapidly, and a saturation of 54% registered on the pulse oximeter while the patient was breathing 100% oxygen via non-rebreathing mask. The arterial blood gas analysis subsequently showed a P_{aO_2} of 117 mm Hg. It is my understanding that a pulse oximeter is capable of reading only "functional" hemoglobin, that is, only the hemoglobin bound with or capable of binding with oxygen.

If the P_{aO_2} was 117 mm Hg, the oxyhemoglobin was 22.2%, and the methemoglobin was 77.4%, the oximeter should have been reading about 98%, since the maximum functional hemoglobin was 22.6% (100% –77.4% methemoglobin) and the actual oxyhemoglobin was 22.2%.

The article gives the impression that a pulse oximeter can detect dysfunctional oxyhemoglobin states, when in fact the oximeter will often mislead practitioners about a patient's true oxygen content when dysfunctional hemoglobin (ie, carboxyhemoglobin or methemoglobin) is present. Why was there a discrepancy with the pulse oximetry readings initially?

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REFERENCE

1. Lunenfeld E, Kane GC. Methemoglobinemia: sudden dyspnea and oxyhemoglobin desaturation after esophagoduodenoscopy. Respir Care 2004;49(8):940–942.

The authors reply:

A pulse oximeter functions by emitting light at 2 wavelengths: 650 nm and 805 nm. It measures the light absorbed as a proportion between those 2 wavelengths. Because various forms of hemoglobin (eg, oxyhemoglobin and deoxyhemoglobin) absorb light at different wavelengths, the pulse oximeter reports an estimated percentage of oxyhemoglobin. However, the pulse oximeter cannot detect other forms of hemoglobin, such as carboxyhemoglobin or methemoglobin. In general, a methemoglobin percentage $> 10\%$ will cause an unreliable oximeter reading that is often lower than expected. Therefore, pulse oximetry should be used only as a screen. Co-oximetry should be used instead to monitor response to treatment.

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Dynamic Hyperinflation, Intrinsic Positive End-Expiratory Pressure, and Respiratory Rate

In the November 2004 issue of RESPIRATORY CARE, I read with great interest the article "Determinants of Dynamic Hyperinflation in a Bench Model," by Drs Thorevska and Manthous.[1] The recognition and management of dynamic hyperinflation and intrinsic positive end-expiratory pressure are very important to all respiratory care clinicians who work with mechanically ventilated patients, and Thorevska and Manthous's work helps to illustrate the related factors. I would like to offer one clarification, related to Thorevska and Manthous's statement that their results differed with those of Tuxen and Lane,[2] and Williams et al.[3] Thorevska and Manthous found that dynamic hyperinflation increased with a decrease in tidal volume (from 1.0 L to 0.6 L) with constant minute ventilation and duty cycle (ratio of inspiratory time to total respiratory-cycle time). They mentioned that this may be due to increased elastic recoil with higher tidal volume, which generates a higher expiratory flow rate, which is correct. But there is another explanation that would account for these findings, as illustrated by the following calculations.

If one delivers a constant minute ventilation with different tidal volumes, different respiratory rates will be required. If a constant duty cycle of 0.25 and a constant minute ventilation of 15 L/min are assumed, it is possible to calculate several variables (Table 1).

From the calculations in Table 1 it is clear that using a larger tidal volume to provide a constant minute ventilation with a constant duty cycle will allow the use of a lower respiratory rate and substantially longer expiratory time. If the mechanical factors of compliance and resistance in the test lung remain unchanged, a longer expiratory time coupled with the higher expiratory flow rate generated by the larger tidal volume will result in improved lung emptying and, thus, reduced dynamic hyperin-

Table 1. Respiratory Variables

Calculated Variables	V_T 0.6 L	V_T 1.0 L
Respiratory rate (breaths/min) required to maintain minute ventilation at 15 L/min	25	15
T_{tot} (s)	2.4	4
T_I/T_{tot}	0.25	0.25
T_I/T_E	1:3	1:3
T_I (s)	0.6	1
T_E (s)	1.8	3

V_T = tidal volume
T_{tot} = total respiratory-cycle time
T_I = inspiratory time
T_E = expiratory time