

Title: PULSE OXIMETRY MAY NOT DETECT ENDOBRONCHIAL INTUBATION

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Introduction. Arterial oxygen saturation monitoring by pulse oximetry is rapidly becoming a standard of practice for general anesthesia. The rapid, reliable detection of inadvertent endobronchial intubation is an important goal of oxygen monitoring. In a previous study of pulse oximetry, only five of nineteen thoracotomy patients developed significant desaturations during one-lung ventilation (OLV) at an FI_{O_2} of 1.0.¹ In a similar study at $FI_{O_2} = 0.5$, the mean pulse oximeter saturation (SpO_2) fell by 3.4% after four minutes of OLV.² Inadvertent endobronchial intubation during anesthesia generally occurs at FI_{O_2} greater than 0.3, and it is unclear a priori whether pulse oximetry will reliably detect these events. This is the purpose of the present study.

Methods. Four dogs were anesthetized with sodium pentobarbital and intubated endotracheally. Arterial and central venous cannulae were inserted through a femoral incision. Two pulse oximeter probes (Novamatrix 500 and Nellcor N-100) were applied to each subject, one to the tongue and one to a toe-web. Transcutaneous PO_2 ($PtcO_2$) was monitored by two probes (Novamatrix 805) on the chest. In addition, arterial PO_2 was continuously monitored by an intra-arterial "optode" fluorescence quenching probe made by American Bentley.³ Arterial samples were also drawn periodically for blood gas analysis. After establishing steady-state conditions for two lung ventilation, OLV was achieved by guiding the endotracheal tube into the right mainstem bronchus with a flexible bronchoscope. Data were recorded at regular intervals for 20 minutes of OLV, during which normocapnia was maintained. The experiment was repeated for five FI_{O_2} values for each dog.

Results. Results of a typical endobronchial intubation at an FI_{O_2} of 0.5 are shown in Figure 1. PaO_2 determined by blood gas analysis or by the optode ($OpPO_2$) begins to fall immediately, and $PtcO_2$ begins to fall in less than one minute. SpO_2 did not decrease significantly in this case, and fell by an average of 4% ($\pm 4.1\%$ std dev) for all dogs at $FI_{O_2} = 0.5$. Meanwhile, $PtcO_2$ fell by an average of 42% and $OpPO_2$ by 64% at this FI_{O_2} . At $FI_{O_2} = 1.0$, the mean decrease in SpO_2 was 1.3% ($\pm 2.1\%$), while $PtcO_2$ decreased by 64% and $OpPO_2$ by 79%. The results for all FI_{O_2} values are summarized in Table 1, which shows mean percentage changes (\pm std dev) in each variable following the onset of OLV. Each of these changes is an average of data from all four dogs.

Discussion. Oxygen monitoring by pulse oximetry is increasingly relied upon to warn of hypoxia during endotracheal anesthesia. Inadvertent endobronchial intubation is a common event that may lead to hypoxia and postoperative complications. The results of this study show that this event may not be reliably detected by pulse oximetry at elevated FI_{O_2} values, with the probability of detection decreasing with increasing FI_{O_2} . There is wide variation among subjects, and some may show little desaturation even

at $FI_{O_2} = 0.3$. Transcutaneous PO_2 shows a significant fall at all FI_{O_2} values within two minutes. The intra-arterial optode shows the most rapid and significant change of the three oxygen monitors evaluated.

References.

1. Brodsky J, et al.: Pulse oximetry during one-lung ventilation. *Anesthesiology* 63:212-214, 1985
2. Viitanen A, et al.: Comparison of transcutaneous oxygen tension measurement and pulse oximetry during one-lung ventilation. *Anesthesiology* 65:3A, A482, 1986
3. Barker S, et al: Continuous fiberoptic arterial oxygen tension measurements in dogs. *J Clin Monit* 3:48-52, 1987

Table 1. Mean percentage decreases (\pm standard deviation) of oxygenation variables during OLV.

$FI_{O_2}\%$	PaO_2	$Op-PO_2$	$NSaO_2$	$PtcO_2$
100	68.3 (± 15)	79.3 (± 10)	1.3 (± 2.1)	63.8 (± 13)
50	62.0 (± 14)	63.8 (± 8)	4.0 (± 4.1)	42.2 (± 13)
30	55.1 (± 13)	45.2 (± 7)	6.0 (± 6.3)	32.9 (± 22)
20	37.6 (± 7)	41.0 (± 6)	9.8 (± 6.1)	31.2 (± 10)
<20	32.0	36.5 (± 6)	19.0 (± 5.0)	40.0 (± 9)

Figure 1. Oxygenation variables vs. time from OLV onset.

