A408

TITLE: SIMULTANEOUS IN-VIVO COMPARISON OF 2- VERSUS 3-WAVELENGTH MIXED VENOUS OXIMETRY CATHETERS

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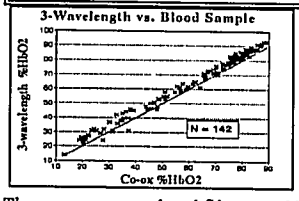
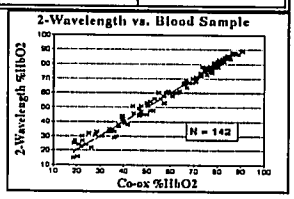
Continuous monitoring of mixed venous hemoglobin oxygen saturation (%Hb-O_2) via fiberoptic catheter is a useful tool in critical care. A major distinction in the design of mixed venous oximetry (MV Sat) systems is the number of wavelengths (λ) used to measure %Hb-O_2 by reflectance spectrophotometry. The Baxter-Edwards Sat-2® uses two wavelengths (660 and 810 nm), while the Abbott Oximetrix® uses three (660, 740 and 810 nm). The additional 740 nm wavelength corrects for changes in total hemoglobin (THb) and has been claimed to provide greater stability.[1] The relative accuracy of 2-λ versus 3-λ systems has never been assessed under identical conditions. For this purpose, we designed an animal model for simultaneous measurement of mixed venous %Hb-O_2 over a wide range of physiologic states.

7 swine (18-22 kg) were anesthetized with pentothal (10mg/kg) and intubated. Mechanical ventilation was set to maintain arterial PCO2 at 40±2 mm Hg. 2-λ and 3-λ MV-Sat catheters were advanced from bilateral internal jugular veins into distinct pulmonary capillary wedge positions, confirmed by pressure tracing and post-mortem exam. Pre-insertion calibrations were done per manufacturers' instructions. Data consist of 142 pairs of simultaneous aspirates of mixed venous blood compared with the corresponding system's displayed value of mixed venous %Hb-O_2. THb and %Hb-O_2 were measured immediately on blood with an Instrumentation Laboratory 382 Co-oximeter. FiO_2 and FiN_2 were mixed so that measured FiO_2 ranged from 0.12 to 1.0. Paired samples were obtained at each FiO_2. Animals were then hemorrhaged to a mean arterial pressure of 50 mm Hg to increase peripheral oxygen extraction and decrease MV %HbO_2. Results:

Device	3-λ	2-λ
Bias (Catheter - Co-ox)	3.71	0.20
Precision (Std dev)	2.30	2.67
R (Catheter vs Co-ox)	0.99	0.99
Decay (Δ in bias/8 hours)	-2.93	0.59





There was no significant difference in the precision of the 2-λ or the 3-λ MV-sat systems when compared with simultaneous blood samples. The 3-λ system had a significantly greater bias ($p > 0.05$ by ANOVA) than the 2-λ system. THb ranged between 7.0 to 13.1 g/dl but did not vary enough in any single animal to require recalibration of the 2-λ system (no changes > 10%).

We conclude: both MV Sat systems performed equally well over a range of %Hb-O_2 from 18 to 90%. Stability is greater and bias is less with the two-wavelength system. Previous studies of these MV-sat systems have not been performed simultaneously under identical conditions.[1] There is no detectable advantage to measuring %Hb-O_2 by reflectance spectrophotometry with three rather than two wavelengths.

References

1. Anesthesiology 66:373-375, 1987.

A409

Title: **HYPERVENTILATION REDUCES SKIN BLOOD FLOW AND TRANSCUTANEOUS OXYGEN IN THE EXTREMITIES**

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In a study of animals undergoing mechanical ventilation, we have shown that the ratio of transcutaneous to arterial oxygen tension (TCI = PtcO2/PaO2) decreases by as much as 80% during hyperventilation (1). In a study of awake, hyperventilating human volunteers, we found more modest decreases in TCI on the chest, roughly 25% change from baseline (2). To resolve this apparent discrepancy, we have measured both TCI and skin blood flow using laser velocimetry on both the chest and extremities in hyperventilating volunteers.

Twelve healthy volunteers were instrumented with radial artery cannulas and PtcO2 electrodes at two temperatures (42 and 44°C), both on the chest and on the extremities. Six of the subjects were also monitored with two laser-Doppler "Laserflo" skin blood flow sensors (TSI Inc., St. Paul, Mn), located on the chest and either the hand or foot. After establishing baseline values, the subjects hyperventilated at 24 breaths/min for 15 to 20 minutes. Noninvasive data (PtcO2, blood flow) were recorded every two minutes and arterial blood samples were analyzed for pH, PaCO2 and PaO2 every four minutes. Data were recorded for an additional 30 minutes following termination of hyperventilation. Statistical significance of changes from baseline values was determined by Student's two-tailed t-test for unpaired data.

Mean and standard deviation values of TCI and PaCO2 before and during hyperventilation for three sensor sites are shown in table1. Delta TCI, which is the percentage decrease of TCI, is greatest for the 42°C sensor located on the hand (73%). It is smallest for the 44°C sensor located of the chest (22%). Similarly, laser-Doppler blood flow decreased by an average of 8% on the chest (n.s.), 60% on the hand, and 51% on the foot ($P<0.01$). The figure shows the behavior of TCI (three sites) and skin blood flow (hand) versus time for a typical subject.

PtcO2 and skin blood flow decrease together during hyperventilation, with much larger decreases on the hand and foot than on the chest. This interesting bit of physiology imposes yet another limitation on the clinical usefulness of PtcO2 monitoring, and it may also affect the performance of other peripheral monitors such as the pulse oximeter.

References

1. Anesthesiology 69 (3A): A280, 1988.
2. Anesthesiology 71 (3A): A371, 1989.

Table 1. Mean and (std. dev.) values of TCI for twelve volunteers.

T_e(°C)	PaCO2 (mmHg)	Mean TCI (Std. Dev.) Chest	Hand	Foot
42	36 (2.8)	.51 (.14)	.27 (.10)	.39 (.16)
	17 (2.5)	.25 (.076)	.072 (.034)	.14 (.073)
delta TCI		51%	73%	64%
44	36 (2.8)	.77 (.10)	.48 (.11)	.63 (.083)
	17 (2.5)	.60 (.069)	.24 (.084)	.32 (.075)
delta TCI		22%	50%	49%

TCI (3 sites) and skin blood flow (hand) versus time. Hyperventilation starts at 12 min. and ends at 40 min.