## A506

TITLE: END-TIDAL $PCO_2$ REFLECTS CHANGES OF CARDIAC OUTPUT

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End-tidal $CO_2$ ($PetCO_2$) tension often decreases during hypotension or hemorrhage and increases during surgical stimulation or blood transfusion. In this study, we examined the possible mechanisms of $PetCO_2$ changes during blood withdrawal both in human and in dogs.

In human studies (Table 1), ventilation was maintained constant and $PetCO_2$ was monitored by Nellcor 1000 when 1000 ml of blood were harvested prior to cardio-pulmonary bypass in 10 patients undergoing coronary artery bypass graft surgery. In animal studies (n=10), blood was withdrawn in two stages (Stage I and Stage II) to produce progressive decrease of oxygen delivery ($\dot{D}O_2$) as described in Table 2.

During blood withdrawal, both in human and dog studies, $PetCO_2$ and cardiac output (CO) decreased significantly (P<0.05), while mixed venous pH (pHv) and $PCO_2$ ($P\bar{v}CO_2$) were unchanged. Arterial $PCO_2$ ($PaCO_2$) decreased insignificantly in human studies but significantly decreased in dog studies at Stage I. Increases of arterial end-tidal $PCO_2$ difference ($a\text{-}ePCO_2$) were insignificant.

During transient changes of CO, content of $CO_2$ in mixed venous blood apparently did not change. Therefore, total amount of $CO_2$ returning to the heart depends primarily on CO. The cause of decreases of $PetCO_2$ during transient decrease of CO may be attributable to decreases of total amount of $CO_2$ return rather than due to ventilation perfusion abnormalities. $PetCO_2$ monitoring can be a useful noninvasive method to assess changes of CO in the clinical states, where ventilation is maintained constant.

Table 1. Human Studies

| | Prior to blood withdrawal | Following blood withdrawal |
|---|---|---|
| $PetCO_2$ : mmHg | 26.0 ± 2.7 | 24 ± 1.8* |
| CO : l | 3.7 ± 0.9 | 2.7 ± 0.5* |
| pHa | 7.46 ± 0.05 | 7.50 ± 0.09 |
| $PaCO_2$ : mmHg | 32.5 ± 3.8 | 31.5 ± 2.4 |
| $pH\bar{v}$ | 44 ± 0.04 | 7.43 ± 0.04 |
| $P\bar{v}CO_2$ : mmHg | 37.4 ± 9.4 | 37.1 ± 3.6 |
| Δ pH | 4.1 ± 1.3 | 6.3 ± 1.3* |
| Δ $PCO_2$ : mmHg | 6.6 ± 1.5 | 7.2 ± 1.7 |
| $a\text{-}ePCO_2$: mmHg | 5.1 ± 3.7 | 6.6 ± 2.8 |

Table 2. Dog Studies

$\Delta pH = pHa - pH\bar{v}$

$\Delta PCO_2 = PaCO_2 - P\bar{v}CO_2$

$\dot{V}ECO = CO_2$ output

*=P<0.05 as compared to C

| | C | Stage I | Stage II |
|---|---|---|---|
| $\dot{V}ECO_2$ : ml/min | 127±22 | 106±23* | 92±33* |
| CO : l | 3.3±0.9 | 1.5±0.5* | 0.99±0.38* |
| $\dot{D}O_2$ : ml/min.kg | 29±7 | 15.4±6* | 9.6±3.8* |
| pHa | 7.32±.08 | 7.33±.08 | 7.25±.11 |
| $PaCO_2$ : mmHg | 44±7.1 | 38.5± 5.4 | 40±8.1 |
| $pH\bar{v}$ | 7.29±.09 | 7.25±.11* | 6.81±.48* |
| $P\bar{v}CO_2$ : mmHg | 50±9 | 52±11 | 62±14* |
| Δ pH | 0.03±0.02 | 0.08±0.04* | 0.09±0.03* |
| Δ $PCO_2$ : mmHg | -5.9±4.7 | -14±9.0* | -22±11* |

## A507

TITLE: CO-Hb IN 1000 SMOKERS AND NONSMOKERS, THE BIOLOGICAL HALF LIFE OF COHb, AND CONSEQUENCES ON PULSOXIMETRY

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Pulse oximetry currently in use determines the oxygen saturation of hemoglobin ($S_pO_2$) on the basis of BEER's law using light of only two wavelengths: 660 and 940 nm. Thus, in the presence of carboxyhemoglobin (COHb) or methemoglobin (MetHb) in human blood the fractional hemoglobin saturation

(1) $SaO_{2frac} = O_2Hb : (O_2Hb + Hb + COHb + MetHb) \times 100\%$

cannot be exactly determined - four wavelengths would be required for analysis of $SaO_{2frac}$[1].

We investigated in the present study with informed consent and approval of the local research committee in which patients COHb and MetHb might complicate the interpretation of $S_pO_2$ and impair oxygen transport. The endpoints were the following:

A - distribution of COHb and MetHb in 1000 smoking (S) and nonsmoking (NS) out-patients,

B - COHb1 before (at arrival in the hospital) and COHb2 after preoperative stop smoking > 10 h (at introduction of anaesthesia) in 50 heavy S, and the biological half life ($t\frac{1}{2}$) of COHb in

C - 9 volunteer S overnight from two measurements, 1-after the last, and 2-before the first cigarette

D - 13 volunteer S during moderate daily activity, calculated from 11 hourly measurements - first sample drawn after stop smoking (COHb-kinetics).

Heparinized samples of 200 µl (as a minimum) of venous blood were measured immediately after withdrawal by the in-vitro CO-oximeter Corning 2500 (Ciba-Corning). Differences were tested in parametric data by t-test and in nonparametric data by Wilcoxon test.

Significance (p<0.05) S vs NS *, men (m) vs women (w) +.

Mean (mn) and/or single values (sv) are presented.

| | | total | w | m | ns | s | w/ns | w/s | m/ns | m/s |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | 1000 | 381 | 619 | 630 | 370 | 288 | 93 | 342 | 277 |
| A | COHb(mn) | 3.05 | 2.45 | 3.41 | 1.82 | 5.13* | 1.78 | 4.52* | 1.85 | 5.34* |
| | MetHb(mn) | 0.66 | 0.69 | 0.64 | 0.66 | 0.66 | 0.69 | 0.66 | 0.63 | 0.65 |

B n=50 (12w, 38m), COHb1(mn)=6.87±1.83, COHb2(mn)=3.77±1.11

| C n=9 | w (mn)+ | (sv) 1 | 2 | 3 | 4 | m (mn) | (sv) 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (sleep) $t\frac{1}{2}$ | 3.18 | 3.23 | 2.32 | 4.30 | 2.85 | 4.67 | 5.59 | 4.73 | 7.06 | 5.58 | 6.4 |

| D n=13 | w(mn)+ | (sv) 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| (awake) $t\frac{1}{2}$ | 2.61 | 3.20 | 2.65 | 2.18 | 2.35 | 2.72 | 2.71 | 2.44 |
| | m(mn) | 8 | 9 | 10 | 11 | 12 | 13 | |
| | 3.69 | 3.39 | 4.18 | 4.02 | 3.69 | 3.38 | 3.46 | |

We conclude from these data that

1. COHb in S (5.13±2.25), even when they stopped smoking (after 10 h: 3.77±1.11) may complicate the interpretation of $S_pO_2$, whereas COHb in NS (1.82±0.3) and MetHb (0.66±0.22) are constant. Thus, pulse oximetry by more than two wavelengths appears desirable.
2. As $t\frac{1}{2}$ of COHb greatly varies, a more than 10 hour period of stop smoking preoperatively may be recommended. On behalf of the significantly shorter $t\frac{1}{2}$ of COHb in women, women might be allowed to stop smoking closer before anaesthesia than men.

References: 1. Anesthesiology 70:98-108, 1989