Effect of Alpha-stat vs pH-stat on Cerebral and Mixed Venous O_2 Saturation During Hypothermic Cardiopulmonary Bypass

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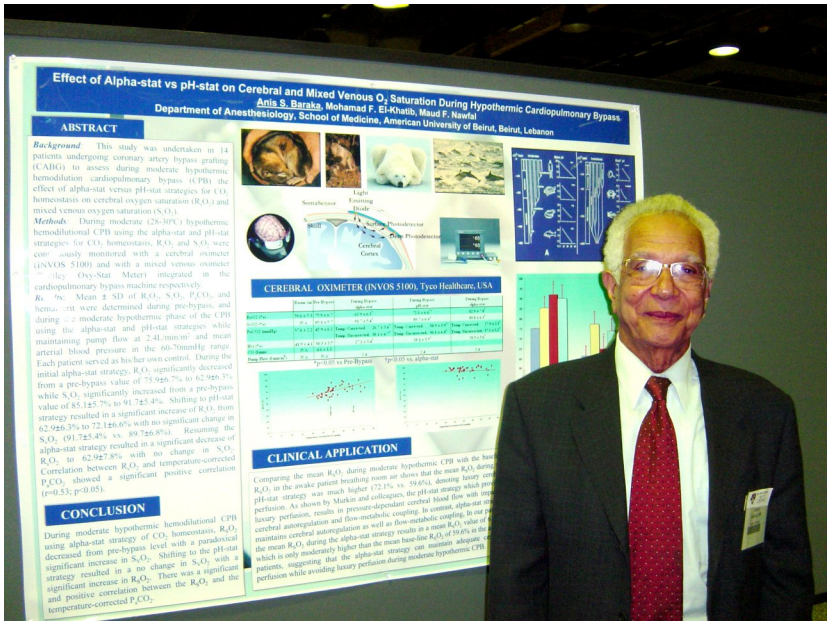


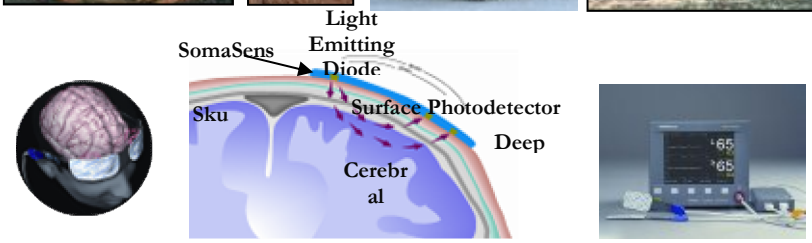
The following poster is modified from its original presented at the 57th annual ASA meeting – October 14-15, 2006 – Chicago - USA

ABSTRACT

Background: This study was undertaken in 14 patients undergoing coronary artery bypass grafting (CABG) to assess during moderate hypothermic hemodilution cardiopulmonary bypass (CPB) the effect of alpha-stat versus pH-stat strategies for CO_2 homeostasis on cerebral oxygen saturation (R_sO_2) and mixed venous oxygen saturation (S_vO_2).

Methods: During moderate (28-30ºC) hypothermic hemodilutional CPB using the alpha-stat and pH-stat strategies for CO_2 homeostasis, R_sO_2 and S_vO_2 were continuously monitored with a cerebral oximeter (INVOS 5100) and with a mixed venous oximeter (Bentley Oxy-Stat Meter) integrated in the cardiopulmonary bypass machine respectively.

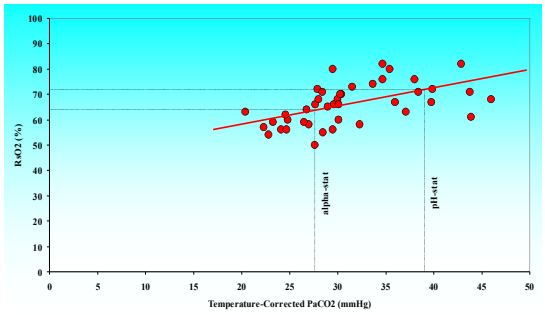
Results: Mean ± SD of R_sO_2, S_vO_2, P_aCO_2, and hematocrit were determined during pre-bypass, and during the moderate hypothermic phase of the CPB using the alpha-stat and pH-stat strategies while maintaining pump flow at 2.4L/min/m^2 and mean arterial blood pressure in the 60-70mmHg range. Each patient served as his/her own control. During the initial alpha-stat strategy, R_sO_2 significantly decreased from a pre-bypass value of 75.9±6.7% to 62.9±6.3% while S_vO_2 significantly increased from a pre-bypass value of 85.1±5.7% to 91.7±5.4%. Shifting to pH-stat strategy resulted in a significant increase of R_sO_2 from 62.9±6.3% to 72.1±6.6% with no significant change in S_vO_2 (91.7±5.4% vs. 89.7±6.8%). Resuming the alpha-stat strategy resulted in a significant decrease of R_sO_2 to 62.9±7.8% with no change in S_vO_2. Correlation between R_sO_2 and temperature-corrected P_aCO_2 showed a significant positive correlation ($r=0.53$; $p<0.05$).

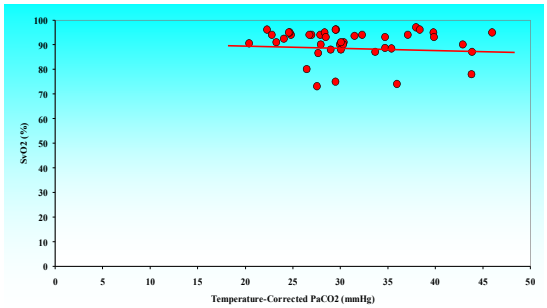


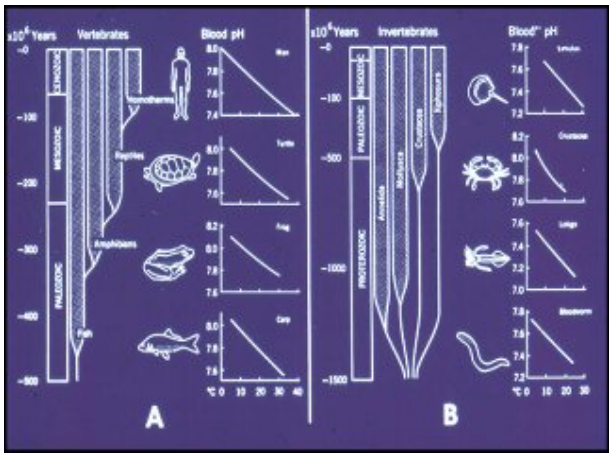
CEREBRAL OXIMETER (INVOS 5100), Tyco Healthcare, USA

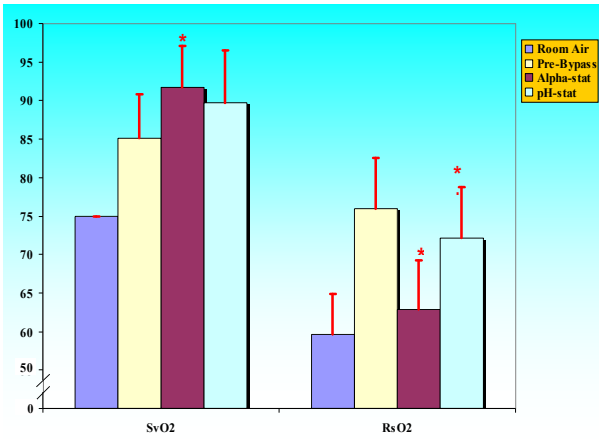
	Room Air	Pre-Bypass	During Bypass alpha-stat	During Bypass pH-stat	During Bypass alpha-stat
RsO2 (%)	59.6 ± 5.3	75.9 ± 6.7	62.9 ± 6.3*	72.1 ± 6.6*†	62.9 ± 7.8*
SvO2 (%)	N/A	85.1 ± 5.7	91.7 ± 5.4*	89.7 ± 6.8*	89.8 ± 6.3*
PaCO2 (mmHg)	37.6 ± 2.2	45.9 ± 6.2	Temp. Corrected: 26.7 ± 3.6* Temp. Uncorrected: 38.1 ± 4.7*	Temp. Corrected: 38.9 ± 3.9*† Temp. Uncorrected: 50.1 ± 6.8†	Temp. Corrected: 27.9 ± 2.3* Temp. Uncorrected: 37.2 ± 3.2*
Hct (%)	41.9 ± 4.1	38.3 ± 3.5	27.1 ± 3.4*	28.1 ± 3.5*	28.3 ± 3.6*
CO (l/min)	N/A	4.6 ± 1.1			
Pump Flow (l/min/m^2)	N/A	N/A	2.4	2.4	2.4

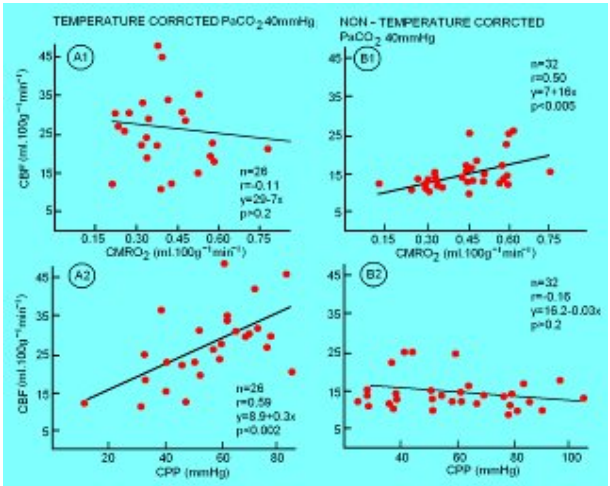
*p<0.05 vs Pre-Bypass †p<0.05 vs. alpha-stat






Vertebrates
Blood pH
Invertebrates
A
B


Room Air
Pre-Bypass
Alpha-stat
pH-stat
SvO2
RsO2


TEMPERATURE CORRCTED PaCO2 40mmHg
NON - TEMPERATURE CORRCTED PaCO2 40mmHg
CBF (ml.100g-1min-1)
CMRO2 (ml.100g-1min-1)
CPP (mmHg)
A1
B1
A2
B2

CONCLUSION

During moderate hypothermic hemodilutional CPB using alpha-stat strategy of CO_2 homeostasis, R_SO_2 decreased from pre-bypass level with a paradoxical significant increase in S_VO_2. Shifting to the pH-stat strategy resulted in a no change in S_VO_2 with a significant increase in R_SO_2. There was a significant and positive correlation between the R_SO_2 and the temperature-corrected P_aCO_2.

CLINICAL APPLICATION

Comparing the mean R_SO_2 during moderate hypothermic CPB with the baseline R_SO_2 in the awake patient breathing room air shows that the mean R_SO_2 during the pH-stat strategy was much higher (72.1% vs. 59.6%), denoting luxury cerebral perfusion. As shown by Murkin and colleagues, the pH-stat strategy which provides luxury perfusion, results in pressure-dependant cerebral blood flow with impaired cerebral autoregulation and flow-metabolic coupling. In contrast, alpha-stat strategy maintains cerebral autoregulation as well as flow-metabolic coupling, In our patient, the mean R_SO_2 during the alpha-stat strategy results in a mean R_SO_2 value of 62.9% which is only moderately higher than the mean base-line R_SO_2 of 59.6% in the awake patients, suggesting that the alpha-stat strategy can maintain adequate cerebral perfusion while avoiding luxury perfusion during moderate hypothermic CPB.