Title: CATECHOLAMINE AND HEMODYNAMIC RESPONSES TO HYPERCARBIA IN INFANTS

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INTRODUCTION

Pulmonary artery pressures and pulmonary vascular resistance in infants are responsive to moderate changes in ventilation but the underlying mechanism is unknown.[1,2] In adults, marked hypercarbia is associated with increases in circulating catecholamines(CA) which may play a role in resultant pulmonary hemodynamic changes. We studied the effects of mild degrees of hyper- and hypocarbia in infants on circulating CA and on transpulmonary flux of CA in infants while pulmonary and systemic hemodynamics were monitored.

METHODS

Following informed parental consent, 17 infants under 1 year of age were studied during controlled ventilation in the postoperative period after repair of ventricular septal defect, atrioventricular canal, or tetralogy of Fallot. All were hemodynamically stable on no inotropic support at the time of the study and had no residual shunts. Arterial, left and right atrial, and pulmonary artery thermodilution catheters had been placed at operation. With inspired oxygen at 40%, ventilation was varied to produce monitored endtidal CO_2s of 20 and then 55 mmHg. Arterial blood gases, cardiac index via thermodilution, and all hemodynamic variables were measured at these values. Blood samples from the pulmonary artery and left atrial catheters were simultaneously obtained for CA assays. CA were measured by a double isotope radioenzymatic assay with coefficient of variations for epinephrine(EPI) and norepinephrine(NE) of less than 7% and 10% respectively. Mean differences were tested for significance with the Mann Whitney U Test.

RESULTS

Mean values and standard errors are summarized in the table. Circulating EPI increased by approximately 300% and NE by approximately 200% as mean $PaCO_2$ increased from 21±2(S.E.) to 54±4 mmHg with commensurate pH changes. No significant differences were found between CA concentrations in pulmonary arterial and left atrial blood at either extreme of $PaCO_2$. Mean pulmonary artery pressure, pulmonary vascular resistance, and mean systemic arterial pressure all increased significantly with this degree of hypercarbia, whereas changes in heart rate, systemic vascular resistance, and cardiac index were not significant although cardiac index tended to increase. The percent increases in pulmonary vascular resistance correlated with the percent increase in circulating EPI measured in the pulmonary artery. ($P < .05$, $r=0.46$, $n=15$)

DISCUSSION

This study shows that relatively mild degrees of hypercarbia previously reported to increase pulmonary vascular resistance in infants are associated with large increases in circulating catecholamines. The significant correlation between changes in circulating pulmonary artery EPI values and pulmonary vascular resistance changes suggests that EPI may have a causal role. Although no net uptake or production of CA across the pulmonary circulation could be demonstrated, this study does not rule out small changes in transpulmonary flux or similar changes in both uptake and production of CA in the pulmonary circulation occurring simultaneously.

REFERENCES

1. Wessel DL, et al: Anesthesiology 67:A526, 1987

2. Morray JP, et al: Anesthesiology 65:A451, 1986

HEMODYNAMIC CHANGES	Hypocarbia	Hypercarbia	P Values
Heart Rate, bpm	143 ± 4	148 ± 6	n.s.
Mean Blood Pressure,mmHg	67 ± 3	81 ± 4	p<0.02
Arterial pH	7.62 ± 0.01	7.29 ± 0.01	p<0.001
Arterial pO_2, mmHg	156 ± 10	130 ± 6	p<0.05
Mean PA Pressure, mmHg	20.6 ± 1.8	35.1 ± 4.1	p<0.001
Cardiac Index, l/min/m²	2.97 ± 0.18	3.86 ± 0.34	n.s.
Sys. Vasc. Resistance,WU	20.7 ± 1.8	19.9 ± 1.4	n.s.
Pulm. Vasc. Resistance,WU	3.66 ± 0.7	7.82 ± 1.6	p<0.005
CATECHOLAMINE RESPONSES			
Epinephrine, nmol/l			
Pulm. Artery levels	1.65 ± 0.65	5.98 ± 2.26	p<0.0025
Left Atrial levels	2.01 ± 0.74	5.95 ± 1.81	p<0.01
Norepinephrine, nmol/l			
Pulm. Artery levels	3.85 ± 0.99	8.04 ± 2.39	p<0.01
Left Atrial levels	4.31 ± 1.05	7.84 ± 1.99	p<0.005

All values = Mean ± SEM; n = 17; Mann-Whitney U test.