Effects of Venous Infusion of Gaseous CO_2 on Cardiac Output of Dogs.* (24761)

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Gaseous CO_2 may be infused into venous system of dogs at rates of 100 ml/min for 3 hours without causing irreversible damage(1). A notable feature of the procedure is reduction of arterial % HbO_2. The following experiment indicates that poor oxygenation of arterial blood during infusion of CO_2 is not a result of pulmonary embolism with resultant reduction in cardiac output.

Methods. Procedure was essentially similar to that previously followed(1) with addition of cardiac output measurements utilizing dye-dilution technics with Evans blue dye, T-1824. Five dogs ranging from 13.2 to 24.6 kg were used, average 19.4 kg. Each dog was observed several days prior to use and deprived of food for 24 hours before experiment. Dial in Urethane (Ciba), 55 mg/kg body weight, was given intraperitoneally. A specially constructed tracheal cannula previously described(2), with screen flow meter, was used. Recordings were made on Miller oscillograph. Arterial blood pressures were measured by Statham pressure transducer attached to polyethylene catheter inserted into right femoral artery. Blood samples for cardiac output determinations were collected from polyethylene catheter in left femoral artery. Another polyethylene catheter was inserted through left femoral vein to vena cava for infusion of pure gaseous CO_2 at average volume flow rate of 87 ml (STPD) of CO_2/min for 30 min. Blood gas analyses were made from samples drawn anaerobically from right femoral artery catheter immediately following cardiac output measurements. Blood samples were analyzed for oxygen content and CO_2 content using Van Slyke manometric procedures(3). Pulmonary ventilation was determined from the product of respiratory rate and tidal volumes measured by planimetric integration of the pneumotachogram. CO_2 concentration in expired gas was continuously analyzed with Liston-Becker CO_2 analyzer. Cardiac output was determined before gaseous infusion, between 29th and 30th minutes of infusion and during 40th minute of recovery. A known volume of 0.5% Evans blue dye, approximately 0.2 mg/kg body weight, was injected into the vena cava from calibrated syringe for each determination of cardiac output. The infusion catheter was immediately flushed with saline. Average concentration of the once-circulated dye and calculation of cardiac output was done according to methods recommended by Hamilton *et al.*(4).

Results. A summary of respiratory and circulatory responses to average venous infusion of 2.6 liters of gaseous CO_2 administered at average volume flow rate of 87 ml/minute is shown in Table I. Qualitatively the results are the same as those reported previously(1). Episodes of tachypnea, bradycardia and hypotension were produced by gas infusion with fairly rapid recovery upon termination of infusion. Recordings made at various time intervals during infusion, showed a very rapid response to introduction of the gas with some indications of steady state during latter minutes of infusion (Fig. 1). The most notable effect of the infusion was the marked increase in respiratory rate, which reached a peak shortly after infusion was begun, leveled to an approximately steady state, then decreased sharply when infusion was stopped (Fig. 1). All values reported are average ratios of experimental to control values of each dog, so that each dog was his own control. Tidal volumes were relatively uninfluenced by infusion. Pulmonary ventilation was sharply increased, almost entirely as a result of rapid breathing rates (Fig. 1). Volume of CO_2 in expired gas increased during infusion and approached a value equivalent to pre-infusion volume plus infused volume/minute. Volumes of CO_2 recovered in expired gas agreed fairly closely with volumes of CO_2 infused.

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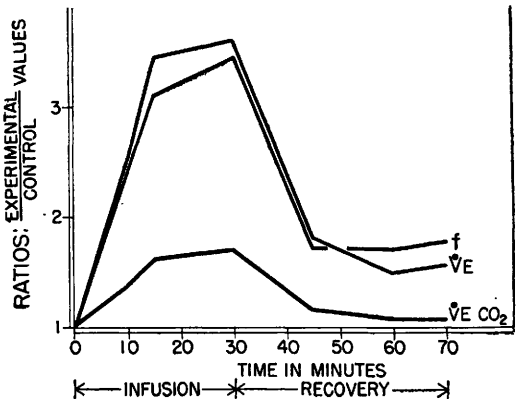

FIG. 1. Influence of venous infusion of gaseous CO_2 on breathing rate, f; minute volume expired, $\dot{V}_E$; and volume of CO_2 expired/min. $\dot{V}_E CO_2$, in relation to control values before infusion.

Cardiac outputs calculated for blood flow before, during, and after infusion are presented in Table I. Cardiac output (blood flow) was 8.7% lower during 29-30th minute of infusion than during pre-infusion measurements. This difference was not statistically significant, $t = 1.24$, $p = 0.30$. On the basis of these data, it is suggested that decreased arterial oxygen saturation during infusion of gaseous CO_2 is most likely due in part to a significant Bohr effect and not to decrease in cardiac output. Something more than the Bohr effect is needed for a complete explanation.

TABLE I. Summary of Respiratory Responses of 5 Dogs to Venous Infusion of Gaseous CO_2.

	Control	After 30 min. infusion	After 40 min. recovery
Respiratory rate	19	63	35
Tidal vol. (BTPS)	158	165	136
Resp. min vol. (BTPS)	3.0	10.4	4.7
CO_2 expired, ml/min. (STPD)	101	179	109
Arterial % HbO_2	90	78	90
" pCO_2	44	53	42
Heart rate/min.	124	113	122
Systolic blood pressure	131	116	115
Diastolic blood pressure, mm Hg	97	80	80
Cardiac output, l/min.	2.3	2.1	2.1

Summary. Cardiac output was measured in dogs before, during, and after intravenous infusion of gaseous CO_2. Slight decreases in output occurred but not great enough to indicate a significant impairment in blood flow through the pulmonary system. Infused CO_2 moves rapidly into the expired gas. Lowered oxygen saturation of blood following infusion of CO_2 can be explained in part by Bohr effect. However, this does not account entirely for level of oxygen unsaturation and something more than Bohr effect seems involved.

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Histamine Releasing Activity of Natural Estrogens.*† (24762)

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In a recent communication dealing with an estrogen-progesterone-histamine complex associated with pregnancy in the rat(1) we indicated that estradiol appeared to release histamine. Spaziani and Szego(2) reported a

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