Date :

Title : RESPONSE TO CO_2 DURING PARTIAL CURARIZATION

Authors : S.H. Rosenbaum M.D., J. Askanazi M.D., L. Rosenbaum M.D., A.I. Hyman M.D., J.M. Kinney M.D.

Affiliation : From the Departments of Anesthesiology, Medicine and Surgery, College of Physicians and Surgeons, Columbia University, New York, N.Y. 10032

Introduction. Respiratory muscle weakness may contribute to respiratory failure and abnormal breathing patterns in severely ill patients and in those recovering from the effects of muscle relaxants administered during anesthesia. This study reports the effect of a CO_2 load on the breathing patterns of partially curarized volunteers.

Methods. The 4 subjects were healthy non-smoking males, aged 20-30 years who had no recent oral intake and who gave written consent to our protocol (which had received our Institutional Review Board's approval). Their breathing patterns were studied with a canopy-spirometer-computer system (1) which consisted of a rigid transparent chamber enclosing the subject's head, ventilated by a high flow of oxygen enriched air connected to a spirometer which provided data for a computerized breath-by-breath analysis. There was no need for the subjects to be encumbered by a mask, mouthpiece or noseclip. Each subject was studied at a moderate level of respiratory weakness defined as a reduction of his peak inspiratory pressure from a normal of at least 115 cm H_2O to approximately 45-50 cm H_2O. To produce this weakness we first used a traditional mouthpiece inspiratory pressure measuring device to determine by slow and careful titration what dose and infusion rate of curare would cause this degree of weakness and maintain it for 15 minutes. On another day, at least a week later, we placed the subject in the canopy-spirometer system and repeated the previously determined schedule of curare administration. The ventilatory response to 3% CO_2 inhalation was studied in the normal and partially curarized states.

Results. The 4 subjects required a mean of 0.22 mg/kg of curare (range .21-24). We observed (Table 1) that most of the increase in minute ventilation ($\dot{V}_E$) caused by the inhalation of 3% CO_2 while partially curarized was reflected by an increase in tidal volume (V_T) with only a slight increase in respiratory rate (f). This increase in tidal volume was due to an increase in inspiratory flow while inspiratory time remained unchanged.

Discussion. Our previous studies have demonstrated that partially curarized subjects breath with an increased V_T and decreased f, with no change in $\dot{V}_E$ (2). Normal subjects in response to CO_2 inhalation increase $\dot{V}_E$ primarily through an increase in V_T. In partially curarized subjects (peak inspiratory pressure = 50 cm H_2O) given CO_2 the increase in $\dot{V}_E$ is not impaired and the mechanism is once again mostly via an increase in V_T. It is of interest that V_T was increased secondary to inspiratory flow rather than inspiratory time, even in subjects with curare induced muscle weakness. This contrasts sharply with the rapid and shallow breathing pattern commonly observed in acutely ill patients.

This degree of curare induced muscle weakness does not appear to alter significantly the ventilatory response to CO_2 inhalation. These data have important clinical implications in the interpretation of abnormal breathing patterns in postoperative patients who have received muscle relaxants.

References.

1. Spencer J, Zikria BA, Kinney JM, et al: A system for continuous measurement of gas exchange and respiratory function. J Appl Physiol 33:523-528, 1972.
2. Rosenbaum SH, Askanazi J, Hyman AI, et al: Breathing patterns during curare induced muscle weakness. Anesthesiology 51:S 367, 1979.
3. Askanazi J, Milic-Emili J, Broell JR, et al: Influence of exercise and CO_2 on the breathing pattern of normal man. J Appl Physiol 47:192-196, 1979.

(MEAN ± SEM)

		V_T ml/m²	f CPM	$\dot{V}_E$ l/m²	T_I s	Insp Flow ml/m²/s
N	0%CO_2	151 ±14	16.0 ±1.3	2.31 ±.25	1.71 ±.27	96 ±16
	3%CO_2	331* ±18	17.7 ±1.2	5.68* ±.20	1.45 ±.09	230* ±8
PC	0%CO_2	165 ±20	15.4 ±1.7	2.45 ±.43	1.62 ±.15	105 ±16
	3%CO_2	383* ±37	18.0* ±1.6	6.66* ±.53	1.64 ±.17	236* ±19

TABLE 1

Breathing patterns in response to CO_2 inhalation in the normal and partially curarized subject. (paired t-test used to compare changes induced by 3% CO_2, *p<.01)

N= Normal
PC= Partial Curarization