Title : BREATHING PATTERNS DURING CURARE-INDUCED MUSCLE WEAKNESS

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Introduction. Respiratory muscle weakness may contribute to respiratory failure and abnormal breathing patterns in seriously ill patients. To help determine the effect of muscle weakness as distinguished from other factors in breathing, carefully titrated doses of d-tubocurare were administered to 4 normal volunteers.

Methods. The subjects were healthy, asymptomatic, non-smoking males, aged 20 - 30 years old who had had no recent oral intake and who gave informed 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 nose clip. Each subject was studied at both mild and moderate levels of weakness, with mild weakness defined as a reduction of their peak inspiratory pressure from a normal of at least -115 cm H_2O to approximately -70 cm H_2O, and moderate weakness a reduction to approximately -50 cm H_2O. To produce these levels of weakness, we first used a traditional mouthpiece inspiratory pressure measuring device, with the subject not in the canopy, to determine by slow and careful titration what dose and infusion rate of curare would cause the desired degree of muscle weakness and maintain it for 15 minutes. On another day, at least a week later, we placed the subject in the canopy-spirometer system without a mouthpiece and precisely repeated the previously determined schedule of curare administration. Each subject was studied, on separate occasions, at both mild and moderate levels of weakness, and served as their own control each time prior to the introduction of the curare.

Results. As expected, the mild level of muscle weakness produced minor drops in the subjects' vital capacity and FEV1, and the moderate level of weakness caused more marked drops in both of these parameters. An unanticipated observation was that partial curarization produced an increase in tidal volume (V_T) and a decrease in respiratory rate (f), each effect proportional to the degree of muscle weakness. Minute ventilation ($\dot{V}_E$) and inspiratory flow ($\dot{V}_I$) remained unchanged. The mechanism of the increased tidal volume was an increase in the duration of each inspiration (T_I), while the inspiratory duty cycle (T_I/T_{TOT}) remained unchanged.

Discussion. The concept of studying $\dot{V}_E$ in terms of inspiratory flow and inspiratory duty cycle, viz:

$$\dot{V}_E = V_T \times f = \dot{V}_I \times T_I/T_{TOT}$$

offers the advantage of having one term that reflects central respiratory activity and another term which reflects "timing." We have applied this analysis to our data (2).

Our previous studies (3) have characterized breathing patterns in acutely ill patients as rapid and shallow. In this respect, muscle weakness secondary to partial curarization is different. However, a consistent finding in both studies was a direct linear relationship between $\dot{V}_E$ and inspiratory flow while T_I/T_{TOT} remains constant.

REFERENCES

1. Spencer JL, 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. Milic-Emili J, Grunstein MM: Drive and timing components of ventilation. Chest 70 (suppl): 131-133, 1976
3. Askanazi J, Silverberg PA, Hyman AI, et al: Patterns of ventilation in postoperative and acutely ill patients. Crit Care Medicine 7:41-46, 1979

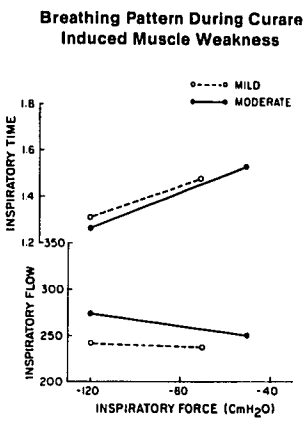

Fig 1

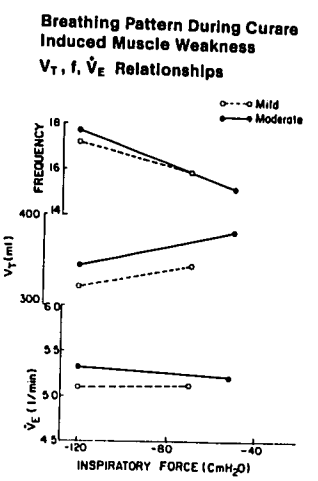

Fig 2