Title : ENFLURANE CONCENTRATION: INFLUENCE OF SEMICLOSED SYSTEM

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Introduction. While the anesthetic concentration delivered by the vaporizer and the actual inspired concentration are equal in an open anesthetic system, in a semiclosed system partial rebreathing with dilution of anesthetic gases can modify this relationship. Since the rate of rise of alveolar concentration (F_A) over inspired concentration (F_I) and the enflurane uptake ($\dot{U}_E$) have been obtained using non-rebreathing high flow systems (1,2), we devised a protocol to determine, in a semiclosed system:

1. The correlation between the concentration of enflurane delivered by the vaporizer (F_{VAP}) and the actual inspired anesthetic concentration (F_I) using different flows.
2. The rate of rise of F_A/F_I and the decay in uptake as a function of time.

Methods. Fourteen patients ASA I-II scheduled for elective surgical procedures were included in this study. The concentration of anesthetic gas and the end-tidal CO_2 ($F_{ET}CO_2$) were measured with a double input mass spectrometer. One of the inputs was connected to the inspiratory limb of the circuit to determine F_I, and the other to a catheter located in the trachea to obtain end-tidal enflurane, considered equivalent to alveolar enflurane (F_A), and $F_{ET}CO_2$. The vaporizer used was a calibrated Vernitrol type. F_{VAP} was calculated from standard equations based on vapor pressure, barometric pressure, flow through vaporizer and total flow (F_{TOT}). $\dot{U}_E$ was calculated according to the following equation:

$$\dot{U}_E = (F_A/F_I - 1) \times F_I \times \dot{V}_A.$$

Alveolar ventilation ($\dot{V}_A$) was calculated from $F_{ET}CO_2$. Data was evaluated using regression analysis, unpaired t-test and Mann-Whitney test.

Results. The difference between F_{VAP} and the actual F_I was flow dependent, fitting the following function

$$y = 7.3e^{-1.6x}$$

($r = -.70$, $p < .001$). With F_{TOT} as low as 1 L/min, $F_{VAP} - F_I$ was 0.79 ± .53; however, with F_{TOT} lower than 1 L/min the difference was 3.4 ± 2.9 ($p < .001$).

F_A/F_I and uptake were comparable with Torri's data.

$F_{ET}CO_2$ showed a negative correlation with F_A/F_I ($r = -0.62$; $p < 0.01$).

Time (min)	F_A/F_I	p	F_A/F_I*	$\dot{U}_E$ (ml/min)	$\dot{U}_E$* (ml/min)
15	.74±.11	NS	.61±.02	30±24	30
30	.76±.05	NS	.67±.01	27±21	22
45	.78±.06	NS	.70±.02	22±16	18
60	.85±.02	<.05	.72±.02	15± 7	17

* Data from Torri et al (1,2).

Values expressed as mean ± standard error.

Conclusions. In a semiclosed system with flows as low as one liter, F_{VAP} represents an adequate indication of the inhaled anesthetic concentration. However, if lower flows are administered the actual F_I cannot be estimated from F_{VAP}.

The $\dot{U}_E$ as well as the rate of rise of F_A in a semiclosed system, even with small flows, is comparable with available data obtained using higher flow and non-rebreathing techniques.

References

1. Torri G, Damia G, Fabiani ML et al: Uptake and elimination of enflurane in man. Brit J Anaesth 44:789-794, 1972.
2. Torri G: Uptake and elimination of enflurane at constant inspired and alveolar concentration. Acta Anaes Belg 25:190-197, 1974.