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Title: ISOFLURANE CONCENTRATIONS DELIVERED BY ISOFLURANE AND HALOTHANE SPECIFIC VAPORIZERS

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Introduction. Isoflurane (Iso), a new volatile anesthetic was recently approved for general clinical use. Because there are no independent reports of the accuracy of Iso delivery from existing Iso specific vaporizers the Iso concentration in oxygen (O₂) delivered under a variety of conditions by a Fortec (Cyprane Ltd) vaporizer was determined. In addition, because the vapor pressure of Iso is similar to that of halothane (Halo) at common operating room temperatures (ie. 250 torr vs 243 torr respectively at 20°C) Iso concentration delivered by three Halo specific vaporizers (Mark 3, Fluotec, Cyprane Ltd; Fluomatic, Foregger Co.; Vapor, North American Drager) was similarly determined.

Methods. The Fortec vaporizer had about 30 hours of Iso delivery use prior to these studies. The Halo vaporizers were recently factory serviced and calibrated for Halo. They had not been in use since return from the factory. A precision rotometer calibrated for O₂ was used to insure accuracy of carrier gas flow to the vaporizer. Gas was sampled from a T piece positioned 20 cm distal to the vaporizer outlet. Anesthetic concentration was determined at zero flow with a calibrated Beckman LB-2 anesthetic analyzer. Ambient temperature within 20 cm of the vaporizer was monitored with a Bureau of Standards thermometer. Room temperature was 22°C. Serial measurements of Iso and Halo concentrations associated with vaporizer dial settings of 0 to maximum percent at O₂ flow rates of 0.375 to 15.0 L/min were performed with all vaporizers. At least 4 measurements were made for each vaporizer setting-flow rate combination and the results averaged. Concentration measured 30 sec. after a dial change was recorded. In addition, the effect on vaporizer Iso output of time (setting constant for 15 min) ambient temperature (15, 22, 30°C) (measurements in Fortec, Fluotec only) and conditions simulating intermittent positive pressure ventilation (IPPV; peak inspiratory pressures of 6, 12, 24 and 48 torr) was studied.

Results. With all vaporizers measured Iso concentrations were generally greater than dialed percentages with lowest O₂ flow rate and less than dialed at higher flows (Fig. 1). Variations in Iso output from dial settings increased for all vaporizers as dial settings approached maximum. The relationship of Halo output (X) relative to Iso (Y) measured during similar conditions fit arithmetic coordinates very well. The equations were: Fortec, $Y=0.145 + 0.998 X$ ($r=0.998$); Fluotec, $Y=0.151 + 1.054 X$ ($r=0.978$); Fluomatic, $Y=0.148 + 1.033 X$ ($r=0.994$); Vapor, $Y=0.157 + 0.985 X$ ($r=0.996$). Changes in environmental temperature altered the

accuracy of both vaporizers studied. Compared to measurements at 22°C changes in Iso concentration were most pronounced at higher O₂ flow rates, and higher vaporizer dial settings at 16°C. Temporal related decreases in delivered Iso concentration occurred with all vaporizers. The magnitude of concentration decrease was directly related to the O₂ flow rate and vaporizer dial setting. Temporal changes at high flow rates were greatest with the Fluomatic and least with the Vapor. There was little effect of IPPV on vaporizer output at peak "inspired" circuit pressures less than 12 torr. More pronounced effects on output were noted at higher pressures. At peak inspiratory pressures of 48 torr peak inspiratory Iso concentrations were as much as 17% greater than expiratory concentrations with the Fortec and Fluotec but decreased by as much as 22% and 79% respectively with the Fluomatic and Vapor vaporizers.

Discussion. These studies suggest that the Fortec vaporizer is as efficient in delivering Iso as a previous study has shown the Fluotec to be in its delivery of Halo.¹ They further suggest that recently serviced vaporizers designed and calibrated for Halo administration also deliver Iso at acceptably predictable and relatively consistent concentrations over a wide range of commonly encountered conditions.

References.

1. Paterson GM, Hulands GH, Nunn JF: Evaluation of a new halothane vaporizer: the Cyprane Fluotec Mark 3. Br J Anaesth 41:109-119, 1969.

Figure 1.

The percent isoflurane in O₂ at various flow rates. Figures to the right of each curve indicate vaporizer dial settings. Ambient temperature is 22°C.

