Title: CONSERVATION OF ANESTHETIC GASES USING THE BAIN CIRCUIT

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Introduction. The Bain circuit is frequently used both for pediatric patients and for adults undergoing unusual procedures such as MRI scanning. Coincidentally, it is also a popular device for use in the third world[1] where cost constraints are even more severe than those in the US. The most expensive aspect of this system is the cost of the high fresh gas flow (FGF) rate required to prevent CO_2 rebreathing. To our knowledge, however, there has been no evaluation of the Bain circuit with regard to the minimum FGF rate required to maintain normocarbia in adult patients. We undertook this investigation to see if the Bain circuit could be used in a more cost-effective manner than has been recommended previously.

Methods. The subjects were 30 healthy adult patients undergoing elective surgery. Anesthesia was maintained with an O_2-N_2O-isoflurane mixture after endotracheal intubation. 20 patients received mechanical ventilation and the remaining 10 patients were supported by assisted ventilation, with every other breath being entirely spontaneous. Inspired and end-tidal gas concentrations for CO_2, O_2, N_2O and isoflurane were monitored with a mass spectrometer sampling from the endotracheal tube. VE was determined with a Wright respirometer placed at the endotracheal tube.

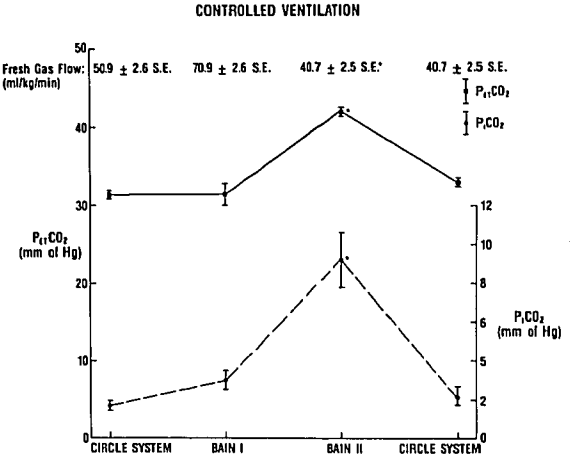
In the controlled ventilation group, cardiovascular and respiratory measurements were performed at the following times: 1) after 30 min. of stable anesthesia using a Drager Narcomed II circle system with VE sufficient to maintain $PETCO_2$ at 30-35 mm Hg, 2) after 30 min with a Bain circuit at the same VE as step 1, with a FGF rate sufficient to keep $PETCO_2$ between 30-35 mm Hg, 3) after 30 min using a Bain circuit with the same VE as step 1 but with the FGF reduced to maintain $PETCO_2$ between 40-45 mm Hg, and 4) 30 min after return to the circle system with the FGF and VE identical to that determined in step 3.

In the assisted ventilation group, measurements were performed at 10 min intervals during 30 min of stable anesthesia using the Bain circuit with FGF titrated to maintain $PETCO_2$ between 40 - 45 mm Hg. Follow-up determinations were performed 10 min after return to the circle system with the identical FGF as was used during Bain circuit anesthesia. In both groups of patients, a single arterial blood sample was analyzed for gas tensions just before termination of Bain circuit anesthesia. Statistical comparisons were performed using analysis of variance with $p<.05$ regarded as significant.

Results. Our results for controlled ventilation are summarized in the figure. VE was held constant at 63 ml/kg/min $\pm$ 1 (mean $\pm$ SE). During Bain circuit anesthesia, we observed that $PETCO_2$ remain 30-35 mmHg with a FGF of 71ml/kg/min $\pm$ 3. In contrast, when $PETCO_2$ was allowed to increase to 40-45 mmHg, the required FGF rate was only 41 ml/kg/min $\pm$ 3 ($p<.05$). Simultaneous arterial pCO_2 determinations at this time showed a $PaCO_2$ of 47.7 mm Hg $\pm$ 0.7.

During assisted ventilation with the Bain circuit, we found that a FGF rate of 52 ml/kg/min $\pm$ 3 was required to maintain $PETCO_2$ between 40-45 mm Hg. Simultaneous $PaCO_2$ was 45.3 mm Hg $\pm$ 1.5 at the end of assisted ventilation with the Bain circuit. No change in heart rate, BP, inspired or end-tidal isoflurane concentration was observed during either study period.

Discussion/Conclusions. These data indicate that clinically satisfactory CO_2 tensions can be achieved with the Bain circuit in adult patients at FGF rates significantly lower than the currently recommended 70 ml/kg/min for controlled ventilation or 100 ml/kg/min for spontaneous ventilation.[2,3] In fact we found unnecessarily low CO_2 tensions at a rate of 70 ml/kg/min. When the Bain circuit is used in adult patients FGF rates of approximately 40 ml/kg/min during controlled ventilation and 50 ml/kg/min during assisted ventilation will achieve both satisfactory CO_2 tensions and considerable costs savings.



End-tidal and inspired CO_2 tensions using constant minute ventilation. All values: Mean $\pm$SE, asterisks=$P<.05$ versus previous data point.

References:
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3. Spoerel WE, Aitken RR, Bain JA. Spontaneous respiration with the Bain breathing circuit. Canad. Anaesth Soc J. 1978;25(1);30.