Title: PATIENT SAFETY: A COMPARISON OF OPEN AND CLOSED ANESTHESIA CIRCUITS

Authors: E.A. Ernst, M.D., T.N. MacKrell, M.D., J.D. Pearson, M.D., G. Cutter, Ph.D. and L. Wagenknecht, M.P.H.

Affiliation: Department of Anesthesiology, The University of Alabama at Birmingham, Birmingham, Alabama 35233

Introduction: Patient safety has been cited as an argument against the use of closed circuit anesthesia.(1) This study was designed to test the hypothesis that closed circuit anesthesia (CCA) and open circuit anesthesia (OCA) are equally safe and effective. After approval by the IRB, 300 randomized general anesthetics were prospectively studied over a three-year period.

Methods: Five anesthesiologists used either system, as dictated by a randomization process, to anesthetize patients, aged 12-78, undergoing general anesthesia for abdominal, orthopedic, or ENT surgery. During preoperative evaluation of patients the day prior to surgery, the anesthesiologist recorded his plan to use isoflurane-O_2 with or without nitrous oxide. Randomization by system occurred the following day. Nothing was done to interfere with each anesthesiologist's style of administering anesthesia except the requirements that total delivery flow during OCA was 5 L/min and during CCA was low enough to keep the circuit completely closed.

To minimize investigator bias, all data were collected automatically or by a research nurse, independent of the anesthesiologist's input. The quality of anesthesia delivery process and outcome was assessed by the following indicators: (1) emergence time (minutes from end of surgery to patient's response to command); (2) post anesthesia recovery scores (PARS) at arrival, 30, 60, and 90 minutes and discharge; (3) total recovery room time; (4) anesthesiologist's ability to predict intraoperative arterial blood gases and isoflurane concentrations, determined by gas chromatography; (5) intraoperative cardiovascular (CV) stability as determined by changes in systolic, diastolic and mean arterial pressure and heart rate (blood pressure and heart rate were measured by a Dinamap and automatically transferred to a data base for later analysis); (6) intraoperative temperature changes; (7) anesthesia complications; and (8) patient satisfaction, comfort and lack of recall during the anesthesia experience (0 to 10; 10 = the best).

Data were analyzed for differences between open versus closed systems using various indicators. The differences were assessed statistically using analysis-of-variance techniques controlling for anesthesiologist, surgery type and use of nitrous oxide. A subjective test was utilized(2) to further evaluate cardiovascular stability. Three closed circuit and three open circuit practitioners viewed graphic presentations of the intraoperative cardiovascular data including systolic, diastolic and mean pressures and heart rates. All were blinded as to type of system that had been used. They were asked to rate each case as to whether the record indicated a desirable or undesirable process and to predict whether the anesthetic was the result of an open or closed circuit. Data from this assessment of circuit type and desirability were analyzed using agreement statistics, kappa and chi-square.

Results: There were no differences in the baseline demographic information of age, sex, preoperative systolic or diastolic pressure, temperature, type of surgery or use of N_2O between the two circuits. Likewise, there were no statistical differences in emergence times, PARS, recovery room times, nor intraoperative temperature loss. Patient satisfaction was excellent following both types of delivery. Complications were limited to postintubation sore throat and vomiting. Transient and minor episodes of arterial hypotension and hypertension were more frequently observed when the open circuit was used.

The prediction ability of the anesthesiologists for blood gas and isoflurane concentrations were not significantly different between the two circuits, although the predicted concentrations of isoflurane averaged 85% of the measured concentrations in the open system and 118% in the closed system. Cardiovascular performance of patients during both types of anesthesia was judged equally satisfactory. While there were differences among observers in the percent rated undesirable, in comparing the proportion of cases between circuits, no significant differences were found. Furthermore, anesthesiologists could not correctly classify circuits. The average kappa statistic was -0.2, implying an average 50-50 chance of correct classification, equivalent to guessing.

Conclusion: This study supports the hypothesis that CCA is as safe and effective as OCA during abdominal, orthopedic and ENT surgery when practiced by anesthesiologists trained in both techniques.

Table. Comparison of open and closed systems.

	Open mean (SE)	Closed mean (SE)	p-value for difference
Emergence time (min)	11.25 (1.43)	8.24 (1.46)	0.07
Arrival PARS	8.31 (0.11)	8.57 (0.12)	0.05
RR time (min)	114.15 (6.87)	120.46 (7.06)	0.44
Δ temp. (°C)	-1.74 (0.11)	-1.73 (0.10)	0.95
Complications	n = 3	n = 5	0.24
Patient rating	9.58 (0.10)	9.77 (0.10)	0.09
Undesirable CV record (%)*	14.85 (3.32)	14.80 (4.44)	0.98

*Judged by blinded practitioners.

References:
1. Smith BE: Dissident observations on closed circuit anesthesia. The Circular 1:5-7, 1984
2. Fleiss JL: Statistical Methods for Rates and Proportions, 2nd edition. New York, Wiley & Sons, 1981, p 212

Funding: Study funded by VAMC grant #81-723