TITLE: DETECTION OF ANESTHESIA MACHINE LEAKS WITH NITROGEN, ENDTIDAL CO2, PACO2 AND PULSE OXIMETRY DURING SPONTANEOUS VENTILATION IN ANESTHETIZED DOGS

AUTHORS: L.C. Jameson, M.D., P.M. Popic, M.D.
AFFILIATION: Anesthesia Department, University of Wisconsin, Madison, WI 53792

Anesthesia risk management programs emphasize the anesthesia machine check out to prevent leaks that could compromise the ability to ventilate a patient. Machine leaks have multiple sources and can occur at any time during the anesthetic. This study was designed to assess the physiologic effect of machine leaks on anesthetized dogs during spontaneous ventilation and the ability of current patient monitors to detect machine leaks.

METHODS: Seven, thirty kg, mongrel dogs* were anesthetized and maintained with 1.5% halothane (H), N2O/O2 using a Modulus I (OHMEDA) anesthesia machine. The dogs were intubated with 6.0 OET with the cuff positioned just below the vocal cords. An 18 gu IV, femoral arterial line and clinical monitors were placed. The standard leaks (2 or 4 l/min at 10 cm H2O anesthesia circle pressure) were placed in the inspired limb, expired limb and in the CO2 absorber of the anesthesia circle. Endotracheal cuff leaks were 5 cm H2O cuff pressure and cuff deflated. During the 10 min control period, the animal spontaneously ventilated with a fresh gas flow (FGF) of 1.7 l/min (0.7:1.0 l/min of O2:N2O) and 5.0 l/min (2:3 l/min of O2:N2O). The standard leaks were introduced and data recorded each minute for 5 minutes. The following data was recorded each minute: end tidal (ET) CO2, tongue pulse oximetry (CritiCare Systems POET®II); inspired N2, O2, H, N2O, ET CO2 (Marquette Gas Analysis Medical Gas Analyzer 1100); tidal volume, minute ventilation and respiratory rate (Ohio 5400 Volume Monitor), arterial BP and heart rate (HR) (Hewlett Packard 78205D Physiologic Monitor). Three ABG were analyzed at the end of each control and study period (Corning 178 pH Blood Gas Analyzer). Statistical significance was considered $p<0.05$ using chi-square analysis.

RESULTS: A physiologic effect was a change in PaCO2 of 1.5 torr or more. For all leaks, a physiologic effect was significantly ($p\leq0.05$ chi-square) more likely to occur during 1.7 l/min FGF (36/47) than 5 l/min FGF (9/44) (table 1). There was no N2 present during the control periods. In all conditions when a significant leak occurred (mean $\Delta PaCO2=-3.00\pm1.37$ torr, n=39), N2 value was $\geq$ 1.0%. N2 always predicted a significant leak ($p\leq$ 0.01). Nitrogen was never present unless a physiologic effect had occurred. The POET®II's ETCO2 value fell more than 2 torr (mean $\Delta X=-4.0\pm1.95$ torr) in 41 of the 45 instances where N2 appeared and PaCO2 decreased. There was no predictive relationship between the PaCO2 and N2 or ETCO2. When a physiologic change occurred, the FGF had no significant effect on $\Delta PaCO2$ (1.7 l/min:2.9 ± 1.4 torr; 5.0 l/min:3.4 ± 1.4 torr) or increase in N2 (1.7 l/min:3.6 ± 2.7 %; 5.0 l/min:2.5 ± 1.8 %). In all cases where PaCO2 and N2 changed, there was a small (-0.2 ± 0.2 %) decrease in ET H. Pulse oximetry did not change during any condition.

DISCUSSION: The change in PaCO2 could not be predicted by known size of machine leak, FGF, ΔETCO2 or ΔN2. During spontaneous ventilation the magnitude of the leak may vary greatly due to inspiratory flow differences between dogs and conditions. Nitrogen always predicted the presence of a significant leak. The fall in ETCO2 and H while consistent were small and may not be clinically noted during spontaneous ventilation. Five l/min FGF significantly reduced the risk of a physiologic significant leak but did not eliminate it.

Table 1. Occurrence of a Physiologically Significant Leak#

Fresh Gas flow	Inspired Leak 2 L/min	Inspired Leak 4 l/min	Expired Leak 2 L/min	Expired Leak 4 L/min	CO2 Absorber Leak 2 L/min	CO2 Absorber Leak 4 L/min	Cuff Leak down	Cuff Leak 5 torr
1.7 l/m	6/6	6/6	6/6	5/6	6/7	5/6	2/6	0/4
5.0 l/m	4/6	2/6	0/5	0/6	0/6	0/6	3/6	0/4

Change in PaCO2 of 1.5 torr or more.

*Study approved by Research Animal Resources Center, Univ. of Wisconsin

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TITLE AN ASSESSMENT OF MEDICAL STUDENT CONFIDENCE IN RECOGNISING THE POSITION OF THE ENDOTRACHEAL TUBE POSITION AFTER INTUBATION.

AUTHORS D. O'Flaherty FFA and A.P Adams MD.
AFFILIATION United Medical and Dental Schools, Department of Anaesthetics, Guy's Hospital, London SE1, UK.

INTRODUCTION The absence of ventilation that may result from accidental esophageal intubation produces hypoxia rapidly and death if not detected in a timely fashion.[1] It is important that all medical personnel are taught to recognise this potential hazard at an early stage in their careers. The objective of this study was to evaluate the ability and confidence of medical students to insert endotracheal tubes correctly and quickly recognise esophageal misplacement.

METHODS With approval from our committee on human research and informed consent, patients scheduled for elective surgery where orotracheal intubation was required as part of the anesthetic technique were studied. 20 medical students, randomly selected from the anesthesiology teaching block which comprises part of their first clinical year, were tested. All had prior theoretical instruction on the techniques of orotracheal intubation. Tracheal intubation was acheived by the medical student under the direct guidance of the investigator. The student was asked after the first attempt at intubation stage whether he or she had correctly placed the endotracheal tube (ETT) relying on the previously taught clinical methods of confirming correct placement. The investigator then decided on the position of the tube using the FEF end-tidal carbon dioxide detector which has previously been shown[2] to be reliable in confirming ETT position. The medical student was blinded to this information. The same student was studied during intubations on three different patients.

RESULTS 30 healthy patients, ASA status 1 or 2, median age 29.5 yr (range 15-64 yr) and weight 65.27 kg (range 49-102 kg) were studied. 7 (35%) of the medical students intubated the trachea correctly at their first attempt. 10 (50%) could make no decision regarding placement of the ETT after this first attempt. However, recognition improved on their second and third attempts (80% and 90% respectively). All 20 students intubated correctly on their third attempt.

DISCUSSION Medical students can obtain consistent results on clinically detecting the position of endotracheal tubes during intubation, with a minimal amount of practical instruction. We feel that this should be reinforced during the introductory anesthesia programme.

REFERENCES

1. Canadian Anaesthetists' Society Journal 1979; 26: 472-8.
2. The end-tidal carbon dioxide detector device: D. O'Flaherty and A.P. Adams. Anaesthesia 1990; 45: (in press).