

Title: RAPIDITY OF DENITROGENATION AT $F_{I}O_2$ 1.0 IN INFANTS

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Introduction. Oxygen breathing prior to anesthetic induction is routinely performed in patients with a full stomach, difficult airway or cardiopulmonary disease. The resulting denitrogenation is typically 96% complete within 2-10 minutes in adults.¹ Since infants have a smaller FRC/kg body weight and a higher respiratory rate than adults, one might expect that nitrogen elimination by oxygen breathing occurs in less time in infants. We designed a study to determine the rate of denitrogenation in normal infants.

Methods. Infants considered for this study presented for general anesthesia indicated by various surgical procedures. With prior approval from our Human Subjects Committee, we studied 15 infants (12 male) ranging in age from 1 day to 52 weeks (mean = 16 weeks), and weighing 2.96-11.2 kgs. Eleven patients were ASA Class I; 3 Class II and one Class III. All patients were free of cardiopulmonary disease. Preoperative laboratory data, including hemoglobin concentration, were within normal limits. All received atropine alone without hypnotic or narcotic agents for premedication. We studied the infants during spontaneous ventilation prior to anesthetic induction. At time zero, we administered air to the patient at either fresh gas flow (FGF) rates of 5 (Group I, 7 infants) or 10 (Group II, 8 infants) liters per minute (LPM) via a Mapleson D circuit and a closely fitted face mask. Inhaled and exhaled gases were sampled via aspiration close to the mouth and nose by means of a sampling catheter inserted into the mask elbow adapter. The sampled gas was analyzed on a breath-by-breath basis for inspired and exhaled concentration of oxygen, carbon dioxide, and nitrogen as well as instantaneous respiratory rate (f) with a Perkin-Elmer mass spectrometer (MCA 1100, Perkin-Elmer Corp., Pomona, CA 91767).

The mass spectrometer was connected to a specially programmed Apple II computer which printed the analysis of each breath. After demonstrating regular respirations, we introduced 100% O₂ in place of air from the anesthetic machine. Oxygen breathing and the resulting denitrogenation continued until the fraction of exhaled N₂ (F_EN₂) was < 5% for at least 3 consecutive breaths. Following this the anesthetic induction proceeded. The data collected on each patient were analyzed and the following variables were recorded: 1) the initial F_EN₂ at the time O₂ was introduced, 2) the number of breaths and time in seconds required to achieve F_EN₂ < 5% for at least 3 consecutive breaths, 3) the mean fraction of exhaled CO₂ (F_ECO₂) during denitrogenation, 4) the fraction of exhaled O₂ (F_EO₂) and the difference between the fractions of inspired and expired oxygen (F_IO₂-F_EO₂) in the

breath when F_EN₂ became < 5%, and 5) respiratory f. We evaluated the difference in the mean time required for denitrogenation in the two flow rates studied (5 LPM vs. 10 LPM) ("t" test for unpaired samples).

Results. The physiologic data are shown in the Table. The mean F_ECO₂ of 4.4% indicates that all infants were adequately ventilating at the time of preoxygenation. The mean f was 25 bpm and the average number of breaths to achieve F_EN₂ < 5% was 12 with a range of 3-25 breaths. With the exception of one child, all infants were able to denitrogenate (F_EN₂ < 5%) during O₂ breathing within 1 minute. The mean time required to achieve denitrogenation was 30 seconds with a range of 14-68 secs. When the mean F_EN₂ became < 5%, the mean F_IO₂-F_EO₂ was 6.2 and the mean F_EO₂ was 90.2%. There was no significant difference in the time required for denitrogenation when the FGF was either 5 LPM or 10 LPM (p > .05).

Conclusions. In healthy infants without cardiopulmonary disease one minute of oxygen breathing is sufficient to ensure an F_EN₂ < 5%. When using the Mapleson D system increasing the FGF above 5 LPM does not accelerate denitrogenation. However, prefilling the gas delivery system with O₂ may decrease the time for denitrogenation.

References.

- Berthoud M, Read DH, Norman J: Pre-oxygenation-how long?: Anaesthesia 38:96-102, 1983

TABLE: SUMMARY OF DATA OBTAINED (n = 15)

VARIABLE	MEAN	RANGE	SEM
f	25	7-38	2.1
(breaths/minute)			
F _E N ₂ (%) (at start)	78.6	76.1-80.6	0.3
F _E CO ₂ (%) (throughout)	4.4	2.2-6.4	0.3
F _I O ₂ -F _E O ₂ (%) (after denitrogenation)	6.2	2.4-10.2	0.6
F _E O ₂ (%) (after denitrogenation)	90.2	85.8-92.5	0.6
No. of breaths (for denitrogenation)	12	3-25	1.4
Time (secs) (for denitrogenation)	30	14-68	3.4