Introduction: Inhalation induction of anesthesia in adults is often accompanied by a prolonged excitement phase, a long induction time and poor patient acceptance. Hence, most anesthetists use and many patients request intravenous thiopental to induce loss of consciousness. In this paper we describe an alternative technique—a single breath halothane induction which is rapid, safe, and readily accepted by patients.

Methods: ASA class I and II patients over 10 years of age without opiate premedication are appropriate candidates. The circle or non-rebreathing system is flushed with 96% oxygen and 4% halothane. The patient is instructed to exhale to his residual volume (R) and hold his breath while a mask is placed tightly on his face. The patient inhales slowly through his mouth to minimize the odor, coughing, and breath holding. After inspiring a vital capacity (V) of 4% halothane, he holds his breath. Tinnitus occurs after 10 sec, loss of consciousness after 15-20 sec, and regular spontaneous breathing ensues. Nitrous oxide is then added to the inspired gas. Inspired halothane concentrations of 3-4% for the next 3-5 min produce a surgical plane of anesthesia.

Theory: Assume instantaneous intrapulmonary mixing and no recirculation of anesthetic in the mixed venous blood. Then \( x_i \) is the halothane leaving the alveoli during the \( i \)th time interval (t) following inhalation of \( V \) with a known inspired halothane tension (\( F_A \)). The blood gas partition coefficient (\( \alpha \)) distributes halothane between the cardiac output (Q) and the alveolar gas. The concentration of halothane in the alveolar gas after \( n \) intervals (\( F_A_n \)) is

\[
F_A_n = \frac{(E_V - \frac{\alpha x_i}{Q} x_i)}{(R + V - \frac{\alpha x_i}{Q} x_i)}
\]

The halothane taken up during time interval \( n+1 \) is \( x_{n+1} \) and is calculated from the quadratic

\[
x_{n+1}^2 - \left( \frac{(R + V - \frac{\alpha x_i}{Q} x_i)}{Q} + \alpha Q t \right) x_{n+1} + \left( \frac{\alpha Q t (E_V - \frac{\alpha x_i}{Q} x_i)}{Q} \right) = 0
\]

Solving for successive \( i \), yields \( F_A \) as a function of breath hold time. (See Fig 1)

Experimental Protocol: The senior author inspired vital capacity breaths of oxygen containing 0.5 to 3.3% halothane, held his breath for 15 sec, and then exhaled. Respiratory gases were monitored by a Perkin-Elmer mass spectrometer (Model MGA 1100A) and processed by a DEC MINC 11/23 laboratory computer to yield \( F_I \) and \( F_A \). (See Fig 1)

Results: Single breath halothane inductions have been used in over two hundred patients during the last five years without extreme excitement or hypotension. Airway obstruction is infrequent and readily managed. Most patients either forget the induction or enjoy it. Some patients fail to exhale to residual volume or to inhale halothane mixtures to full vital capacity. They simply require multiple breaths at the same \( F_I \) to lose consciousness.

\( F_A \) at the first expiration does not exceed the safe level of 1.5%. (Fig 1). The subsequent 10-15 spontaneous breaths at the same \( F_I \) show only small further increases in \( F_A \). The \( F_I \) required to produce amnesia (point A, Fig 1) was 1.5% and resulted in \( F_A \) of 0.42%. The \( F_I \) required to produce divergent gaze and unresponsiveness was 3.3% (point B, Fig 1). The resultant \( F_A \) of 0.82% approximates the ED50 for halothane anesthesia (1). The addition of 70% nitrous oxide to the inspired gas lowers the \( F_I \) needed for unresponsiveness to 1.5%.

Discussion: The single breath halothane oxygen induction appears to be a suitable alternative to intravenous thiopental but the patient must be able and willing to perform a vital capacity maneuver. This technique is reminiscent of cyclopropane inductions of the past (2). Single breath inductions with iso-flurane or enflurane may be difficult because of airway irritability. Currently we are extending our volunteer studies and preparing a movie to illustrate the technique.

References:

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Fig 1.

- \( R = 1690 \text{ ml} \)
- \( V = 4680 \text{ ml} \)
- \( T = 2.3 \)
- \( Q = 4000 \text{ ml/min} \)