

Title: NITROUS OXIDE UPTAKE IN ADULTS

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Introduction. In publications on nitrous oxide many workers of inhalation anesthetics related their uptake to a power function. For example, the rate of nitrous oxide uptake is expressed by $1000 \text{ cc t}^{-1/2}$; halothane uptake is given by $50 \text{ cc t}^{-1/2}$. However these approximations made in the derivation of the $t^{-1/2}$ function, in fact, do not separate FRC washin from true body uptake and no consideration on effect of inspiratory concentration. Only the anesthetics taken up by the blood across the alveolar membrane should be considered as true body uptake. The uptake of inhalation anesthetics was examined with the use of mass spectrometry.

Methods. (1) Inspired and expired anesthetic concentration was continuously measured breath by breath at the end of the endotracheal tube. FRC was measured with He and anatomical dead space was measured by pneumotachograph from CO_2 and volume curve. After a set of combined FRC washin and uptake curve (*in vivo*) was obtained with an inhalation anesthetic from the patient under high dose fentanyl - O_2 - relaxant anesthesia, with constant volume ventilation, patient's lung was replaced with a rubber bag of similar size and obtained *in vitro* curve of FRC washin without uptake. From *in vitro* curve subtract *in vivo* curve and obtain the true body uptake across the alveolar membrane. (2) The fresh-gas nitrous oxide concentration was increased in steps of 10% at a total fresh-gas flow of 10,000 ml/min. With constant volume ventilation, inspiratory-expiratory differences in nitrous oxide concentration represent the uptake of N_2O after a brief period of FRC washin. Patients approval obtained.

Results. (1) Show reduction of the nitrous oxide uptake with time after 3 min.

N_2O Uptake	1st min	2nd min	3rd min	30 min	60 min
50% (n=30)	87±18	144±18	204±22	133±20	106±15
60% (n=20)	96±17	173±15	226±28	158±24	122±13

The first minute of uptake is less than the second minute; and the peak uptake is around the third minute. This is quite contrary to previous works

which demonstrate that rapid reduction is in the first few minutes. (2) Uptake is the function of the inspiratory concentration; inspired concentration increases as the uptake increases.

Discussion. These measurements demonstrate the previous workers failed to separate FRC washin from true body uptake. The FRC of the patient can be considered as an extension of the circuit or a large dead space.

When one uses 60% nitrous oxide at the beginning of washin, 1800 cc of nitrous oxide must be administered to fill the average 3000 cc of FRC before uptake begins. It also demonstrated that the first minute of uptake is less than the second or third minutes' uptake, simply because N_2O washin into a relative large FRC space could not reach its peak inspired concentration in the first breath or first minute.

This finding clarifies the overestimation of the existence of "second gas effect" and "diffusion hypoxia". It also serves as a scientific foundation of the practical and simple closed-circuit anesthesia. Once washin has been achieved, uptake no longer need to be considered as following a complex exponential or a power function, but can be regarded as constant for clinical purposes. With infinitely long time constants of closed-circuit anesthesia and concentration dependent uptake across alveolar membrane by the pulmonary circulation, according to the law of mass action, closed-circuit anesthesia can be performed with ease and safety using current available equipment.

References.

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