Title: NEW INDEX (E.B.C.) FOR POTENCY OF INHALATION ANESTHETICS

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Introduction. The use of mass spectrometry to rapidly and accurately measure the inspired and expired concentration of anesthetic gases makes possible the non-invasive determination of the mixed venous concentration of anesthetic agents which in turn might serve as a new index of anesthetic potency.

Methods. If one assumes or experimentally maintains constant ventilation and cardiac output during the process of uptake and since the solubility coefficient will be constant for any given agent, only the pressure gradient will influence the uptake, so uptake can be addressed as Uptake = K (C1 - C0).

Where K = membrane factor, C1 = inspired concentration, C0 = mixed venous blood concentration. After washing into the FRC, uptake can be expressed by C1 - C0 or 1 - F0/F1 where F0 and F1 are fractions in percent or in partial pressure of the alveolar and inspired gases respectively. The uptake of the agent across the alveolar capillary membrane (i.e., the pressure gradient), a factor K can be described by

\[ K = \frac{F1 - F0}{F1 - F0} \text{ where } F0 \text{ is the concentration of the agent in mixed venous blood. Assuming the } F0 \text{ would be 0 at the end of the washin, then} \]

K = \frac{F1}{F1} or K = 1 - \frac{F0}{F1}

With K determined at the end of washin for a given agent, the mixed venous concentration can be estimated at any time during anesthesia using the inspired and expired concentrations by

\[ F0 = \frac{F1 (K-1) + F0}{K} \]

These formulas were tested in 10 mongrel dogs anesthetized with 25/mg/kg pentobarbital. Cardiac output was monitored for constancy by an electromagnetic flow probe placed by thoracotomy and ventilation was controlled using N20 + O2 with halothane. Mixed venous samples were obtained through a Swan-Ganz catheter introduced through a jugular vein. The blood samples were analyzed for halothane using a gas chromatograph.

Results. The correlation between determinations made on the mixed venous blood and that calculated using the mass spectrometer was approximately 0.9. The correlation of incidental measurements made on patients undergoing cardiac surgery and anesthetized with N20 + O2, morphine, and halothane is shown in figure. In all calculations, a halothane blood gas solubility coefficient of 2.3 was used.

Discussion. This excellent correlation raises the possibility of utilizing this technique to obtain a potency value similar to MAC but relating instead an effective blood concentration to the response to a stimulus. This refinement would rule out variability caused by washin and the uptake by organs in the fast circulation groups, both of which can easily result in misinterpretation of the point of equilibration time. This is accomplished by breath by breath measurement of concentrations which clearly identifies the initial rapid rise in FA/F1 ratio described for nitrous oxide and similar to halothane as FRC washin and not true body uptake. Following the few minutes of FRC washin, the inspiratory/expiratory concentration difference which indicates true body uptake rate becomes relatively constant. Records indicate that, with a constant inspired or constant tidal concentration of the agent, that for significant periods of time (at least one hour), there is no equilibration between the agent in the alveolus and in the blood. Thus, the described non-invasive technique for determination of mixed venous concentration and therefore an indication of concentrations in organs such as brain may be used to arrive at a more accurate index of anesthetic potency at a more clearly definable time during an anesthesia.

Fig. 1

Comparison of halothane concentrations in blood by two methods

References.