Title : ANESTHETIC UPTAKE USING A NEW MASS SPECTROMETER SYSTEM

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Introduction. Application of the mass spectrometer to the practice of anesthesia is becoming increasingly common for measurement of inspired and alveolar gas tensions. These measurments have proven to be important for assessing the induction and maintenance of anesthetic delivery, as well as for training and education of anesthesiologists. This paper describes a system in which a new mass spectrometer is combined with a flowmeter to provide measurement of the breath-to-breath uptake of anesthetics, CO_2 production, and O_2 consumption.

Methods. A miniature quadrupole mass spectrometer with a unique servo-controlled gas sampling valve has been combined with a flowmeter. Both instruments are interfaced with an on-line computer system which controls the operation of the mass spectrometer and records the signal from the flowmeter. This simultaneous measurement of gas flow and gas concentration is used for a breath-to-breath calculation of gas transport. The computerized mass spectrometer-flowmeter system is shown schematically in Figure 1. The computer controlled inlet system positioned in the flowmeter obviates the need for a capillary tube, eliminating any transit delay of the sampled gas, thus providing increased stability and accuracy of the instrument.

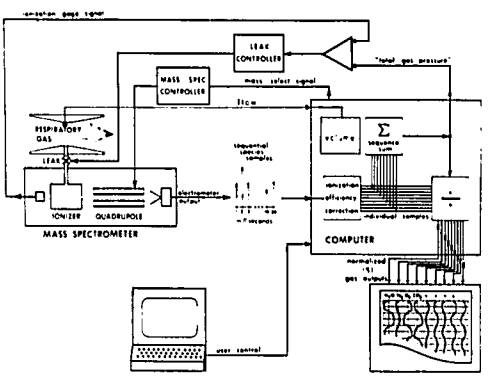

Fig. 1. A computerized quadrupole mass spectrometer combined with a flowmeter. The computer determines gas concentrations and gas volumes and controls the mass spectrometer gas inlet system.

The computer selects the gases to be sampled, reads the mass spectrum, corrects for cross-spectra interference, calculates the sum of all gases present, and generates a control voltage for the servo-controlled inlet valve. This control voltage causes the inlet valve to maintain a constant flow of gas into the mass spectrometer.

Results. By multiplying the gas concentration with respiratory flow over the inspiratory cycle and subsequently over the expiratory cycle, then subtracting the value obtained for the expiratory cycle from the one obtained for the inspiratory cycle, the net gas uptake by the lung for one breath is determined. This is shown for N_2O in Figure 2.

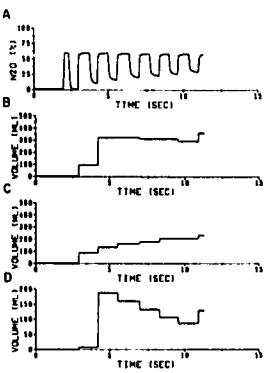

Fig. 2. The computation of N_2O uptake: (A) N_2O "concentration"; (B) inspired N_2O volume; (C) expired N_2O volume; (D) breath-to-breath N_2O uptake.

Summary. The development of mass spectrometer and flowmeter systems coupled to a computer provides breath to breath measurement of gas exchange. Thus the system provides valuable data for assessing the behavior of anesthetic uptake and physiological gas transport. Applications now being developed include: 1) gas transport in the steady and unsteady state during rest and exercise, 2) non-invasive measurement of cardiac output and the determination of lung water, and 3) uptake of anesthetics and control of anesthesia delivery.