

Laboratory Report

Gas Chromatographic Assay of Volatile Anesthetics:

Some Problems and a Solution

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A modification of the gas chromatographic procedure of Fink and Morikawa (ANESTHESIOLOGY 32:451-455, 1970) for measuring inhalation anesthetics is presented. Emphasis is placed on separating vehicular gas from anesthetic vapor by using appropriate column packing material and assay conditions. (Key words: Measurement techniques, gas chromatography.)

SEVERAL PROBLEMS were encountered when assaying volatile anesthetics by gas chromatography using column packing and other conditions previously described.¹ One problem was that measurement of volatile anesthetics in liquid samples by the Fink-Morikawa equilibration technique¹ produced values that differed unpredictably from expected values. Another problem was that gas samples taken directly from anesthetic vaporizers employing O₂ as carrier and diluent gas often extinguished the flame ionization detector (flashback) or produced high values. A solution to these is presented here.

Methods

The assays were carried out using a Varian Aerograph Model 1200 gas chromatograph equipped with a flame ionization detector and a 0.5-ml gas-sampling loop. The 6-foot × 1/8-inch ID glass column was filled with

Porapak-Q, 80-100 mesh (Waters Associates, Inc., Framingham, Mass.). The detector temperature was 230 C and that of the column 180 C. The following gas flows were used: H₂, 25 ml/min; He, 25 ml/min; O₂, 200 ml/min.

The procedures for calibrating the standard tanks of anesthetics and for determining the concentrations of volatile anesthetics in liquid samples were based upon the method described by Fink and Morikawa.¹ Standard tanks of halothane and ether were purchased from Linde Division, Union Carbide, and tanks of enflurane from Airco.

For test purposes saline solution was equilibrated with volatile anesthetics delivered from a Copper Kettle vaporizer via gas-dispersion tube. The system was designed so that liquid and vapor samples could be removed without opening to ambient air. The thermometer was immersed in the liquid for temperature corrections and an equilibration time of 60 min was employed.

Results and Discussion

When using the column packing and assay conditions previously described¹ for determining concentrations of volatile anesthetics, the vehicular and anesthetic gases were not separated. Their simultaneous arrival at the detector caused unpredictable combustion due to variable concentrations of O₂ in the vehicular gas. Therefore, Porapak-Q column packing was employed in order to produce conditions that separate O₂ and the anesthetic. Burning the flame with O₂ instead of air (without separating the gases) did not correct the poor results. But the use of O₂ in the flame ionization detector was continued to

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Received from the Department of Anesthesiology and The Anesthesia Research Center, School of Medicine, University of Washington, Seattle, Washington 98195. Accepted for publication June 1, 1976. Supported by NIH Anesthesia Research Center Grant GM-15991.

TABLE 1. Measured Anesthetic Concentrations* in Gas and Aqueous Samples

| | Estimated from Vaporizer | Volumes Per Cent | |
|---------------|--------------------------|------------------|------------------|
| | | Gas | Saline Solution |
| Halothane | 1.0 | 1.02 (1.01-1.03) | 0.94 (0.91-0.97) |
| | 2.5 | 2.46 (2.44-2.48) | 2.24 (2.20-2.27) |
| Enflurane | 3.0 | 2.83 (2.81-2.88) | 2.60 (2.55-2.65) |
| Diethyl ether | 3.0 | 3.07 (3.06-3.08) | 3.07 (3.04-3.09) |

* Each measured value is an average of values for three samples, with the range in parentheses. For details, see Methods.

insure complete ionization of highly halogenated anesthetics such as halothane and enflurane. This also increased the sensitivity fiftyfold. Using O_2 in the flame ionization detector and Porapak-Q column packing, we have measured halothane concentrations as low as 0.02 per cent by the Fink-Morikawa technique.

Concentrations of halothane, enflurane and diethyl ether measured in the aqueous and vapor phases after equilibration are shown in table 1. The retention times for ether (2.6 min), enflurane (2.8 min), and halothane (3.6 min) suggest that adequate separation for simultaneous assay of a mixture of these gases could be achieved at a lower column temperature.

A disadvantage of switching columns as described is that time for analysis of each sample is increased from about 35 minutes to 45 minutes (two 15-minute equilibration periods plus column retention time). On the other hand, the 10 minutes sacrificed markedly improve reliability of determinations.

In summary, the modifications of the Fink-Morikawa¹ procedure for measuring volatile anesthetics described above improve the accuracy and sensitivity of the technique.

Reference

1. Fink BR, Morikawa K: A simplified method for the measurement of volatile anesthetics in blood by gas chromatography. *ANESTHESIOLOGY* 32:451-455, 1970

Renal Function

SURGERY FOR RENOVASCULAR DISEASE Renovascular disease produces a form of hypertension potentially curable by surgical intervention. This report analyzes morbidity and mortality in 502 patients who underwent 577 operative procedures. Operative mortality was 5.9 per cent. Eight of the 34 deaths occurred 40 to 375 days after operation; the death rate within one week after operation was only 1.7 per cent. Operative mortality with atherosclerotic renovascular disease was 9.3 per cent, while only 3.4 per cent of patients with fibromuscular hyperplasia died. Myocardial infarction was

the most common cause of death after simple nephrectomy. When the surgical procedure was complicated, major causes of death were uremia, hemorrhage, or both, sometimes with the additional complication of infection. Uremia was the most important cause of mortality, resulting in 12 of the 34 deaths reported. Additional determinants of mortality were bilateral renal disease and concurrent extrarenal operations. (Franklin SS, and others: *Operative Morbidity and Mortality in Renovascular Disease*. *JAMA* 231: 1148-1153, 1975.)