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General Anesthesia without O_2 Analyzer—A Substandard Practice

To the Editor:—In response to the question, "Can we do without O_2 analyzers?" raised by the letter of Drs. Ditchik and Herr,[1] the answer is a resounding "No!" As the patient's advocate in the operating room, we cannot justify delivering a general anesthetic without an O_2 monitor of some reliable type. In light of the wealth of case reports and letters in the anesthesia literature, wherein mishaps causing hypoxia are described, vigilance demands a functional calibrated O_2 analyzer or equivalent.[2]

A properly placed O_2 monitor may warn of numerous unforeseen problems as faulty flowmeters,[3] unexpected delivery of gases other than oxygen,[4] delivery of hypoxic mixtures, disconnections from the anesthesia machine,[5,6] and other equipment misadventures. It is of significance that an O_2 analyzer often can help detect mishaps long before the patient becomes hypoxic and diagnosed by severe aberrations of vital signs. Oxygen analyzers should be the standard of practice on delivery of every general anesthetic, as the warning of dark blood on the field may be sounded only after a hypoxic catastrophe has occurred.

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Portable Semiclosed Circuit for Prolonged Oxygen Administration in Aircraft

To the Editor:—Transportation of seriously ill patients in aircraft often involves prolonged administration of therapeutic oxygen (O_2). Federal governmental guidelines allow the patients' physicians to prescribe the design of the O_2 administration circuit used as well as the fresh O_2 flow rates (personal communication, Walter S. Luffsey, Associate Administrator for Aviation Standards, United States Department of Transportation). Semiopen circuit breathing devices, which are adequate for short-term O_2 support, are undesirable for long-term support, as they require relatively large fresh gas flow rates to prevent rebreathing. The bulk and weight of O_2 supply cylinders may be a limiting factor, especially in small aircraft.

The ability of a given semiopen circuit design to conserve oxygen flow rates while preventing rebreathing is often dependent on whether ventilation is spontaneous, assisted, or controlled.[1] In contrast, semiclosed breathing circuits allow the use of high inspired oxygen concentrations at low fresh gas flow rates while preventing rebreathing during either spontaneous, assisted, or controlled ventilation. Theoretically, after denitrogenation of the patient and the anesthesia circuit, fresh O_2 flows equal to or greater than the patient's O_2 consumption

TABLE 1. Comparison of Fresh O_2 Flow Economics of Magill, Bain, and Semiclosed Circuits

Circuit	Ventilatory Model*	Fresh O_2 Flow	Reference	"E" Cylinder Exhaustion Time (min)
Magill	S	72 $ml \cdot kg^{-1} \cdot min^{-1}$	2	131
	C†	20 $l \cdot min^{-1}$	3	33
Bain	S	153 $ml \cdot kg^{-1} \cdot min^{-1}$	2	62
	C	70 $ml \cdot kg^{-1} \cdot min^{-1}$	4	134
Semiclosed with absorber	S or C	15 $ml \cdot kg^{-1} \cdot min^{-1}$	‡	628
Semiclosed without absorber	S or C	60 $ml \cdot kg^{-1} \cdot min^{-1}$	5	187

* S = spontaneous; C = controlled.
† Not recommended for assisted or controlled ventilation.[3]
‡ See text for discussion.

will result in the safe administration of inspired O_2 concentrations near 100%. Inadequate fresh gas flows will result in deflation of the reservoir bag, regardless of the overflow valve adjustment.

In table 1 we have estimated the comparable exhaustion times of a size "E" O_2 cylinder using the Magill (Mapleson A), Bain (Mapleson D), and semiclosed systems for spontaneous and controlled ventilation. The exhaustion time calculations assume an "E" cylinder volume of 659 l, and a 70-kg subject with an oxygen consumption of 5 $ml \cdot kg^{-1} \cdot min^{-1}$. Fresh O_2 flows of three times the patient's O_2 consumption were arbitrarily chosen for the semiclosed system. As one can readily see, the semiclosed system results in considerable conservation of O_2 supplies.

The bulk of conventional carbon dioxide (CO_2) absorbers often makes the semiclosed system awkward to use during patient transportation. We have used the following portable semiclosed circuit (fig. 1) during prolonged aircraft transportation of patients with satisfactory results. The system, previously described by Viegas *et al.*,[6] consists of an O_2 source, O_2 tubing for conduction of fresh gas flow, a disposable CO_2 absorber complete with two unidirectional valves and an overflow valve (DISP CO_2 SORB®, Dryden Corporation, Indianapolis, Indiana), and disposable anesthesia circuit tubing and bag. Excluding the tank, the system weighs a mere 1.3 kg and costs approximately $12.

The portable semiclosed system can be modified to suit the needs of the individual patient. Boehringer valves (Boehringer Laboratories, Wynnewood, Pennsylvania (fig. 1) may be added to the expiratory limb of the circuit to provide positive end-expiratory pressure (PEEP),[6] and airway pressure may be continuously monitored by adding a pressure gauge to the circuit. Although the design of the portable absorber results in better humidification of inspired gases than occurs with conventional CO_2 absorbers,[7] addition of an "artificial nose" (Engstrom Edith, Engstrom Medical AB, Bromma, Sweden) (fig. 1) to the circuit may further improve humidification.[8] When vehicle seating arrangements preclude sitting by the head of the patient, variations in the anesthesia tubing length will allow one to accommodate these limitations without adversely affecting the dead space of the circuit.[3] During transportation, the

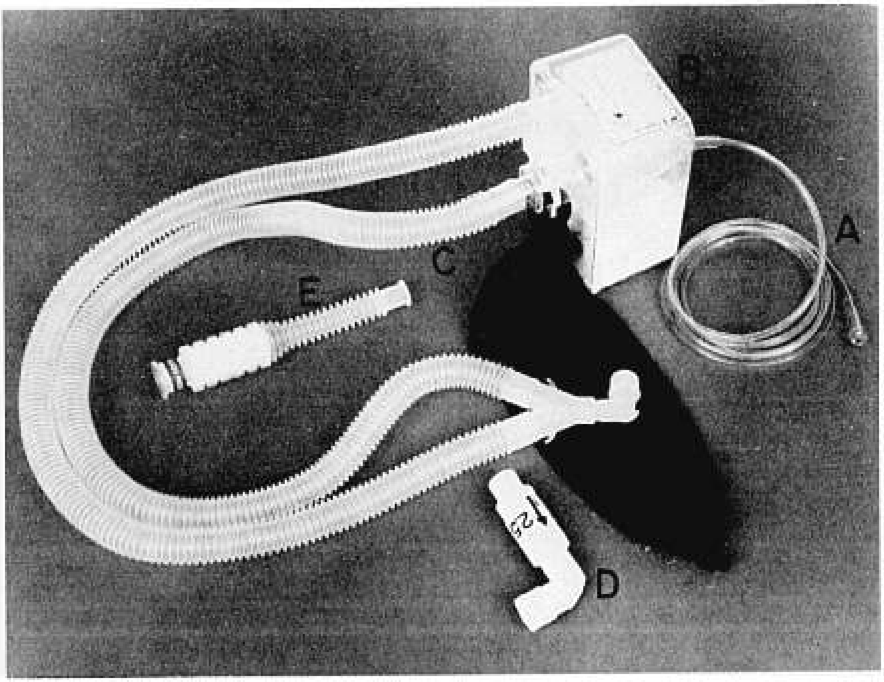

FIG. 1. Portable semiclosed anesthesia circuit: O_2 tubing (A), disposable CO_2 absorber (B), and disposable anesthesia tubing and bag (C). Options may include PEEP valves (D) and an "artificial nose" (E).

absorber can be mounted on the transporting vehicle,[6] or a sling can be fashioned from 2-inch-wide tape, allowing the person administering ventilatory support to carry the absorber on the shoulder like a purse.

Viegas *et al.* estimate a 5- to 12-h exhaustion time for the portable CO_2 absorber.[6] Their estimate does not consider that, using the portable anesthesia circuit in a semiclosed fashion as we propose, a portion of the patient's CO_2 production will be expelled through the overflow valve. We feel that their estimates of exhaustion time are conservative; however, accurate prediction of the true exhaustion time is not possible.[3] Should exhaustion of the absorber occur during flight, rebreathing can be prevented by increasing fresh O_2 flow rates to 60 $ml \cdot kg^{-1} \cdot min^{-1}$ and increasing ventilation threefold. Such flow rates compare favorably with the Magill and Bain circuits (table 1).

In our experience with the described portable semiclosed circuit, oxygen flow rates of 50% minute ventilation proved adequate for spontaneous, assisted, and controlled ventilation. We have not experienced CO_2 absorber exhaustion during transportations of up to 4 h duration.

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Who Was the Man, A. W. Von Hofmann?

To the Editor:—New words and phrases spring upon professional populations and spread with the same rapidity as they do among teenagers. They often become accepted cliches with a meaning assigned by consensus rather than history. The phrase "Hofmann Elimination" may be such a phrase. Who was the man, A. W. Von Hofmann?

August Wilhelm Von Hofmann was born in Giessen, Germany, April 8, 1818. He studied chemistry at the University of Giessen under Justus Von Liebig and received the degree of Ph.D. Summa Cum Laude in 1841. He continued as assistant to Liebig up until 1845, when he became Assistant Professor of Chemistry at Bonn University. Later in the same year he became first Director of the new Royal College of Chemistry in London. In 1843 Hofmann established the nature of aniline. His research on coal tar led to his discovery of benzine in 1845, along with the development of a technique for preparation of aniline from benzine. After this Hofmann began his famous work on amines.[1]

At the age of 33 years, Hofmann first described the "Hofmann Reaction," named after his method of converting amide to an amine by degradation of quatenary ammonium salts under alkaline conditions with loss of water, and the formation of a tertiary base. A typical reaction is shown by the following:

$$HO^- + HCH_2{-}CH_2{-}N^+R_3 \xrightarrow[100^\circ C]{pH\ 12} H_2O + CH_2{=}CH_2 + NR_3$$

The elimination is bimolecular and leads to removal of one of the beta hydrogens and breaking of the alpha carbon–nitrogen bond. This reaction is promoted by electron withdrawal as a result of the positive charge on the quatenary nitrogen. The course and rate of the