

inevitably a stressful procedure. The results show that low-dose beta blocker therapy is not effective in producing therapeutic plasma levels and that medium dose therapy is not effective in producing sustained therapeutic levels. Patients receiving larger propranolol doses (> 320 mg/day) have been shown to maintain therapeutic plasma levels, even if the final preoperative dose precedes surgery by as much as 24 h.¹⁸ However in clinical practice in the United States, the average daily propranolol dose may be as low as 90 mg/24 h.¹⁹

We conclude that low-dose propranolol therapy (40–80 mg/day) is ineffective in producing therapeutic plasma levels, and that if therapeutic levels are desired at the time of anesthesia and surgery, then dosage ought to be increased. Medium dose propranolol (160 mg/day) and metoprolol (100 mg/day) is more likely to result in therapeutic levels, but such levels will become subtherapeutic unless oral therapy is maintained to within a short period of departure for the operating room.

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Misleading Mass Spectrometer Reading Caused by an Aerosol Propellant

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The mass spectrometer (Perkin-Elmer Medical Gas Analyzer, MGA-1100) displays a carbon dioxide waveform and inspired and expired partial pressures for

oxygen, nitrogen, carbon dioxide, nitrous oxide, halothane, enflurane, and isoflurane. Accuracy of the partial pressure values is in part predicated on the fact that

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no other gas will be introduced into the system. This case demonstrates the effects of such an extra nonrespiratory and nonanesthetic gas.

REPORT OF A CASE

A 42-year-old, 75-kg man was scheduled for resection of a left internal carotid artery aneurysm. Four days previously he had had a subarachnoid hemorrhage apparently secondary to the aneurysm. He was neurologically intact and stable. He had chronic hypertension treated with hydrochlorothiazide. He smoked one pack of cigarettes a day for over 30 years. He took reserpine, kanamycin, Decadron*, cimetidine, phenobarbital, codeine, and epsilon aminocaproic acid. All laboratory studies were within normal limits.

After diazepam was administered, a precordial stethoscope and ECG leads were applied. Peripheral iv cannulae and an arterial catheter also were inserted. At this time the patient had mild end-expiratory wheezing, which cleared after coughing. After administration of oxygen, anesthesia was induced with thiopental, 700 mg iv, in divided doses; fentanyl, 0.4 mg; lidocaine, 100 mg; and pancuronium, 10 mg iv. Immediately after tracheal intubation, the patient began wheezing again, and ventilation was difficult. The wheezing responded promptly to increasing the inspired isoflurane concentration. After induction of anesthesia, skeletal muscle twitch height and temperature were monitored and esophageal stethoscopy and mass spectrometry also were utilized. The patient was then positioned, head tongs were placed, and surgery proceeded. Anesthesia was maintained with nitrous oxide, isoflurane, oxygen, and pancuronium.

Hypotension was induced at the time the aneurysm was dissected; the inspired isoflurane concentration was raised to between 3 and 4%. The patient again began to wheeze. The anesthesia circuit, mass spectrometric data, and endotracheal tube were checked and found to be functioning normally. As bronchospasm persisted despite high inspired isoflurane concentrations, a metered isoproterenol inhaler (Norisodrine* Aerotrol*, Abbott Laboratories) was inserted between the anesthesia circuit and the endotracheal tube and several metered doses were dispensed. The bronchospasm resolved, however the mass spectrometer alarm signaled and displayed an inspired isoflurane partial pressure of 65.89 mmHg (fig. 1), although the vaporizer (Ohio 0309-0290-800) was set to deliver only 3% (23 mmHg). The next mass spectrometer readout, one-half minute later, was again in accordance with the vaporizer setting. Later in the case, recurrent bronchospasm was treated again successfully with the metered aerosol. Again the inspired isoflurane partial pressure, as measured by the mass spectrometer, rose to a level much higher than that set on the vaporizer. At the end of surgery, the patient was awake; the trachea extubated; and no neurologic abnormalities were evident. Postoperative wheezing was treated with nebulized isoethrane.

After an uncomplicated postoperative course, the patient was discharged from the hospital 1 week later.

DISCUSSION

Reliability of the mass spectrometer can be tested in several ways. One quick check is performed by summing the partial pressures of the inspired gases. The sum of dry gases should total 760 mmHg \pm 1% at sea level. If the spectrometer is set to wet gas (saturated alveolar measurements), the partial pressures should add up to 713 mmHg. This spot check should not take the place of routine calibration. After totaling the in-

PATIENT ID:
STATION # 7 DATA 17:00 04/23/83 17:00
STNS MON 7 REPT SCAN:
CO2 O2 N2 N2O HAL ENF ISO
INSP MM .00 393.6 226.4 329.8 .30 .00 65.89
EXP MM 31.08 376.9 33.4 291.8 .00 .00 17.93
RESP PRINTING
BLOOD PH:
RESP RATE: 5.0 I:E: 1: .84 EXP TIME:5.5

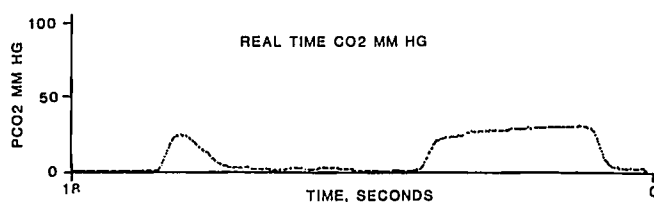


FIG. 1. Mass spectrometer printout with 3.5% isoflurane anesthesia after isoproterenol is introduced by propellant. Note that 65.89 mmHg inspired isoflurane is equivalent to more than 8.5% inspired isoflurane.

spired partial pressures in figure 1, it is apparent that the sum exceeds 760 mmHg and therefore the readout must be viewed with suspicion. A large amount of inspired nitrogen also is registered, which indicates the break in the circuit that occurred when the inhaler device was inserted. Since the total pressures still should not exceed 760 mmHg, this cannot explain the impossible sum of 1016 mmHg that our unit displayed. We conclude that the algorithm of our mass spectrometer was not programmed to deal with the circumstances presented.

Besides a properly functioning machine, reliability of the readings also presupposes no introduction of gases other than those for which the machine is designed. Our mass spectrometer can detect only those gases that it is programmed to measure. When we introduced an ionizable aerosol (the propellant, the drug, or both), two problems arose: a new gas was introduced and the new gas had a mass spectrum that overlapped that of isoflurane. This explanation was examined by exposing four different drug preparations to our mass spectrometer: isoproterenol hydrochloride (Norisodrine* Aerohalor*, Abbott Laboratories), albuterol (Ventolin*, Glaxo Inc.), metaproterenol sulfate (Alupent*, Boehringer Ingelheim, Ltd.), and isoproterenol hydrochloride (Isuprel*, Breon Laboratories) with similar propellants. We noted that these gases were displayed uniformly as isoflurane. Because we used several drugs, each with similar propellant, and all were interpreted as isoflurane, we concluded that the propellant, a combination of chlorofluoro-hydrocarbons, in each of these aerosols was responsible for our results with the Perkin-Elmer* MGA-1100.

Mass spectrometers bombard the sample gas mixture with electrons, which fragment and ionize the

sample to various degrees, depending on the physical properties of the different molecules. The resultant ions then are projected into the analyzer compartment where a magnetic field influences the distance the various ions traverse.¹ The charge and mass of the ions determine how the accelerating mechanism and magnetic field distribute the ions on the analyzer's collector plates. The electronic collection plate signals then are translated into digital signals, which are displayed on the screen.

Each of the compounds we monitor, *i.e.*, oxygen, carbon dioxide, nitrogen, nitrous oxide, halothane, enflurane, and isoflurane, have partially unique mass spectral qualities. Because they ionize differently, even isomers such as enflurane and isoflurane can be distinguished by the instrument. The mass spectrometer algorithm is written to calculate the concentrations of the gases as a fraction of their differences and corrects for their mass spectral similarities by a process referred to as spectrum overlap erasing.²

The fluorinated hydrocarbon propellants we used

apparently all generate a signal at mass 91, at which a strong isoflurane mass peak also occurs. Without a specific algorithm to erase the spectrum overlap for the propellant, the unit interpreted it as isoflurane. This problem did not occur in tests we conducted with the Chemetron SARA mass spectrometer system. In the Perkin-Elmer system, the presence of propellant at one sampling station did not affect subsequent measurements from that station or from other stations.

The misleading isoflurane partial pressure secondary to the presence of this type of propellant is avoided easily by not dispensing medication with such a propellant while the spectrometer is sampling.

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Inhibition of Epinephrine Absorption by Dextran

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To obtain optimal local hemostasis in patients undergoing surgery, cutaneous infiltration of a dilute solution of epinephrine is performed. The safe dose of epinephrine for adults under halothane anesthesia has been reported by Katz *et al.*,¹ Johnstone *et al.*,² Melgrave,³ and Wallbank.⁴ Recently, Karl *et al.*⁵ have demonstrated that children can tolerate greater amounts of epinephrine on a body weight basis than adults. The use of epinephrine together with halothane, however, is still controversial, even when the dose is kept within

the "safe dose." This is because even amounts far smaller than the "safe dose" of epinephrine can produce unfavorable circulatory effects, especially when injected into vascular-rich tissue such as the scalp.⁵

One of the suggested causes of the reaction is a rapid increase in the plasma level of epinephrine.⁴ We, therefore, measured the plasma concentration of epinephrine after its injection into the scalp, with the objective of elucidating the causative mechanism of the adverse reaction. This study also was designed to address the effect of dextran, infiltrated concomitantly with epinephrine, on the transfer of epinephrine to the blood.

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MATERIALS AND METHODS

After obtaining approval from the committee for the protection of human subjects and informed consent, we studied 35 ASA I and II patients who were scheduled for elective craniotomy. The age range was from 35 to 77 yr, and their mean weight was 55 Kg. The anesthesiologists were allowed to choose the agents and