The 9-volt MN 1604 battery that we use is rated for a 10–15 per cent decrease of ampere hour capacity after one year of storage, and 25 per cent after two years. At a current drain of 20 milliamperes, a typically higher discharge rate, the battery voltage will drop to half in about 30 hours.

Because of the variable conditions of use encountered, it is not possible to specify an absolute quantitative usable life for the battery. We therefore recommend changing the battery every six months. In addition, we check the batteries and alarm before the start of each operation, as well as at intervals intraoperatively.

REFERENCES

An Unusual Case of Hypercarbia during General Anesthesia

SANFORD L. KLEIN, D.D.S., M.D.,* AND J. KENNETH LILBURN, M.D.†

With the nearly universal application of semiclosed anesthesia systems, the use of carbon dioxide as an adjunct to anesthetic care has been essentially eliminated. Carbon dioxide is still used, however, as an insufflating gas for laparoscopy, and has other minor uses, so it sometimes is supplied from a central source in the operating room. We describe an event in which accidental crossing of central nitrous oxide and carbon dioxide supply systems caused profound hypercarbia in a patient undergoing general anesthesia.

REPORT OF A CASE

A 60-kg, 19-year-old, white female patient was scheduled for emergency total colectomy with a diagnosis of toxic megacolon. Except for the presenting illness, her history was unremarkable. Anesthesia was started with meperidine, 100 mg, iv, thiopental, 250 mg, iv, and pancuronium, 6 mg, iv. Ventilation was controlled, with administration of nitrous oxide, 3 l, oxygen, 2 l, and enflurane, 1–2 per cent. After 5 min, the trachea was easily intubated, after which breath sounds were determined to be equal bilaterally. Five minutes later, arterial blood pressure and heart rate increased from 130/70 to 180/120 torr and from 60 to 160 beats/min, respectively. Additional meperidine, 100 mg, iv, was given. The reservoir bag and carbon dioxide absorber then became warm to the touch. Although esophageal temperature remained normal, the patient became extremely flushed, especially about the head and neck. Enflurane administration was discontinued when systolic blood pressure suddenly decreased to 80 torr with a heart rate of 140 beats/min. The electrocardiograph showed a widening of the QRS complex. Arterial blood-gas values were: \( p\text{H}_2 \) 7.098, \( \text{Pa}_\text{CO}_2 \) 116 torr, and \( \text{Pa}_\text{O}_2 \) 461 torr. The reservoir bag and the carbon dioxide canister were so warm that it was difficult to maintain contact with them. Esophageal temperature, however, remained normal. Hyperventilation with 100 per cent oxygen gradually reduced the flush, hypertension and tachycardia. A thorough search of the immediate area of the machine revealed that the blue nitrous oxide central supply line attached to the back of the machine was interlocked with the central carbon dioxide supply line. Thus, the gas supplying the nitrous oxide flowmeter was actually carbon dioxide. The line was inserted into the correct receptacle; nitrous oxide–oxygen–enflurane administration was resumed. After 10 min, repeated analysis of arterial blood gases showed values within normal limits, and the procedure continued uneventfully. The incident had no further ill effect on the patient.

DISCUSSION

Prys-Roberts et al.\textsuperscript{1} assigned three main causes of gross hypercarbia: 1) inadequate ventilation; 2) re-breathing of exhaled carbon dioxide; 3) supplying exogenous carbon dioxide to the breathing apparatus. Our case clearly falls into the last category. These cases usually entail inadvertent administration of machine-mounted carbon dioxide due to damaged or ignored rotameters.\textsuperscript{2–4} Our case is unusual in that the hypercarbia was caused by crossed central supply lines despite all the usual precautions and fail-safes. All of our central supply gases are brought into the operating room through an Ohio Medical Products\textsuperscript{5} "retractable surgical ceiling column"; connections between the gas lines in the ceiling column and the gas lines mounted on the anesthesia machines are achieved through Ohio Medical Products "Diamond" Quick-Disconnect Adaptors. All of these adaptors are

* Assistant Professor of Anesthesia and Oral Surgery.
† Visiting Assistant Professor of Anesthesia.

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Address reprint requests to Dr. Klein.

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color-coded, and all interfaces are safety-keyed. All gas installations are less than 4 years old and conform to NFPA standards. As can be seen from figure 1, which is a photograph of a correct carbon dioxide receptacle, the index system consists of two notches around the periphery of a flat disc, a narrow notch at 11 o'clock, and a wide notch at 6 o'clock. In figure 2, a photograph of the installation involved in this case shows that both notches are correctly placed but both are wide. The width and location of the notches determine which male adaptor can be interlocked with that particular receptacle. Nitrous oxide and carbon dioxide adaptors have their pins at the same angles. Ostensibly the carbon dioxide receptacle (notched at 6 and 11 o'clock) and the nitrous oxide receptacle (notched at 1 and 6 o'clock) are not interchangeable; however, they are mirror images of each other, and rotation of the male hose end lines up the pins and notches correctly. The only thing that prevents the interchange of carbon dioxide for nitrous oxide is the one narrow notch on the carbon dioxide receptacle.

When both notches are wide, as in figure 2, the possibility for interchange results. The reverse interchange, that is the carbon dioxide hose into nitrous oxide adaptor, is unstable and will not remain connected in our columns. Investigation after the incident reported showed that the index plates on all the columns in 12 operating rooms opened in July 1976 were installed incorrectly. Until recently, we used a “Diamond” to “Schrader” pigtail on all of the gas supply columns, since we had “Schrader” hose fittings on the anesthesia machines. We eliminated these extra junctions to reduce gas leakage by going to “Diamond” fittings on the anesthesia machines. We cannot determine whether installation of the column index plate was a responsibility of the manufacturer or a contractor; however, other columns installed two years later (fig. 1) had the correct receptacle plates. Installation of proper receptacle plates has eliminated the possibility of a repetition of this type of incident.

We feel that a more elaborate indexing system with three or more notches, some of them hexagonal...
or other shapes, sized to prevent small square pins from fitting into large round holes, with no design being the mirror image of any other, should be used.

References

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Plasma Catecholamine and Cortisol Responses to Fentanyl-Oxygen Anesthesia for Coronary-artery Operations

Theodore H. Stanley, M.D.,* Lawrence Berman, M.D.,† Orville Green, M.D.,‡ David Robertson, M.D.§

Anesthesia with high-dose fentanyl (50–100 μg/kg) and oxygen has been suggested as an alternative to morphine or halothane anesthesia in patients undergoing major vascular surgical procedures and valvular or coronary-artery bypass open-heart operations.1–4 Advantages of this technique include absence of cardiovascular depression or stimulation during anesthesia and operation and attenuation of some hormonal stress responses to surgical stimulation. In a previous investigation it was shown that high-dose fentanyl anesthesia does not influence plasma concentrations of antidiuretic hormone, a hormone that is frequently increased with stress, and prevents increases of this hormone that usually occur during surgical stimulation.5 The effect of fentanyl-oxygen anesthesia on plasma catecholamines and other stress-responsing hormones has not been measured. In this study we measured plasma epinephrine, norepinephrine, dopamine, and cortisol concentrations during anesthesia with high-dose fentanyl-oxygen before and at numerous intervals during operation in 18 patients undergoing coronary-artery revascularization procedures.

Methods

All patients were ASA class III and were scheduled to undergo multiple-vessel elective coronary-artery bypass operations. No patient was receiving propranolol, but ten were taking nitroglycerin on occasion for angina. Written informed consent to perform the study was obtained from each patient at the time of the preoperative visit. All patients were premedicated with diazepam, 10–12 mg, im, and atropine, 0.3–0.5 mg, im, 90 min prior to the scheduled time of operation.

Upon arrival in the induction room, catheters were placed in two peripheral (hand) veins and the radial artery. The radial-artery catheter was threaded into the central aorta. The arterial catheter was attached through an arterial pressure transducer to a central digital computer substation in the operating room. The computer was calibrated as previously described6 and Warner's method of analyzing the central aortic pulse–pressure curve was used to determine heart rate, mean arterial blood pressure, and cardiac output.5 Electrocardiograph leads were then applied to the patient's extremities and the patient allowed to breathe 100 per cent oxygen.

Following a 15-min period of breathing oxygen, a 9.5-ml blood sample was obtained from the arterial line via a 10-ml syringe filled with 0.5 ml heparin (1000 units/ml). In addition, cardiac output, heart rate, and mean arterial blood pressure were measured. Fentanyl was then administered intravenously at a rate of

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