Occurrence of Hypercarbia Due to an Unusual Failure of Anesthetic Equipment

MICHAEL D. DETMER, M.D.,* PHOOL CHANDRA, M.D.,† PETER J. COHEN, M.D.‡

We report an unusual cause of equipment failure resulting in hypercarbia. The diagnosis, management, and methods of prevention are discussed.

REPORT OF A CASE

A 64-year-old black woman with a two-year history of intermittent, transient episodes of unconsciousness, dimming of vision, and weakness in the left arm was diagnosed as having cerebrovascular insufficiency due to extracranial disease of the carotid and vertebral arteries. She was scheduled for carotid endarterectomy with bypass graft from the carotid to the vertebral artery on the right side. She was 172 cm tall and weighed 58.6 kg. She had a history of heavy smoking and alcohol abuse for more than 30 years, had limited exercise tolerance due to shortness of breath, and was allergic to penicillin. Surgical history included cholecystectomy, bilateral inguinal herniorrhaphy, and repair of a tibial fracture. Both general and regional anesthesia had been administered without problem. No other major medical problem was found, but in the past she had been treated with an unknown pill for shortness of breath.

Results of laboratory investigations, except for cerebral angiography, which confirmed the admission diagnosis, were within normal limits. A significant carotid bruit was present on the right side. Vital signs were normal. Results of abdominal, heart, and lung examinations were unrevealing except for occasional rhonchi in the right lower lobe.

The patient was premedicated with morphine, 5 mg, im, and scopolamine, 0.4 mg im. Following precyclopropane for 5 min, induction was achieved with thiamylal, 260 mg, iv, and pancuronium, 10 mg; tracheal intubation was completed after spraying the trachea with 4 ml of 4 per cent lidocaine. Following tracheal intubation, bilateral breath sounds were heard. Maintenance of anesthesia was with enflurane, 1–2 per cent, in 50 per cent nitrous oxide in oxygen, with a total flow of 3 l/min. Ventilation was controlled mechanically using an Airshield Ventilator (700 ml/ tidal volume; respiratory rate 10/min) in a semiclosed circle system. Vital signs were maintained with a cardiac rate of 80–90/min, arterial pressure 100/60–120/70 torr, and temperature 35.7 C. The electrocardiogram and temperature were monitored, and an arterial line was placed to follow intraoperative blood pressure and blood-gas values.

The first arterial blood-gas sample was taken approximately 46 min after induction of anesthesia. Because ventilation appeared adequate, we were surprised to find significant hypercarbia (table 1). A quick check of breath sounds and a search for any obstruction to flow of gases, mechanical kinks, or leaks was unrevealing. Chest movement was adequate and symmetric. The expired volume of gases as measured by a Wright Respirometer was equal to the ventilator setting. The soda lime appeared to be suitably fresh, for it showed no change in color. The concentration of CO₂ in the inspired gas was not measured. Because an immediate search for a source of the problem was unsuccessful, ventilation and fresh gas flows were increased, with the results shown in table 1. A marked increase in ventilation produced a normal PaCO₂. On the other hand, increasing the fresh gas flow while minute ventilation was actually lower than measured initially also corrected the hypercarbia.

DISCUSSION

Hypercarbia was discovered fortuitously in this case, because blood pressure and pulse were unaltered, and the soda lime did not change color. Investigation revealed that our hospital had recently acquired a new supply of soda lime (Soda lime, Analytical Reagent, Mallinckrodt, P.O. Box M, Paris, Kentucky 40361) that contained no indicator dye and appeared physically similar to our usual brand (Sodasorb®), which contains ethyl violet as the indicator dye.1 The absorber had been purchased from a hospital that was closing; that institution had apparently used the chemical without problem. The physical characteristics of the new absorber were obtained from the manufacturer (personal communication from Mallinckrodt, Inc.): 4–8 mesh, 0.76 per cent weight loss on drying, and a carbon dioxide absorption capacity of 34 per cent. Those for Sodasorb are 4–8 mesh, 14–19 per cent weight loss on drying, and a CO₂ absorption capacity of more than 22 per cent.2 Exposure to carbon dioxide confirmed the lack of color change in the absorber—it remained white both during its period of effective

---

* Instructo of Anesthesiology.
† Assistant Professor of Anesthesiology.
‡ Professor and Chairman of Anesthesiology.

Received from the Department of Anesthesiology, University of Michigan Medical School, Ann Arbor, Michigan 48109. Accepted for publication October 26, 1979.

Address reprint requests to Dr. Detmer.

---

0003-3022/80/0300/0278 $00.60 © The American Society of Anesthesiologists, Inc.
absorption§ and after exhaustion. Apparently the soda lime at fault had been used on the previous day and, although depleted had not been changed due to its lack of color change.

CONCLUSION

Efficient carbon dioxide absorption can be relied on only during the periods in which the material is fresh, the effective period varying with the product's chemical composition and moisture content, as well as such factors as fresh gas flows, circuit configuration, packing, and size of the cannister. Because blood-gas analysis is not routine in every case, and because clinical signs of hypercapnia are not always present during anesthesia (as in this case), significant hypercapnia may develop without the anesthesiologist's knowledge.

In addition, this case illustrates that potentially hazardous complications can occur when certain anesthetic supplies are bought by purchasing agents unfamiliar with the specific needs of the anesthesiologist.

REFERENCES

1. Adriani J: Soda lime containing indicators. Anesthesiology 5:45-52, 1944
2. The Sodasorb Manual, Dewey and Almy Chemical Division of W.R. Grace and Company

§ Although the low moisture content of the analytic reagent soda lime might have been expected to decrease its efficiency, less than 1 per cent CO₂ escaped from a canister filled with a fresh sample of this soda lime exposed to 3 l/min of 5 per cent CO₂ for nine hours.