Contamination of an Anesthesia System with Liquid Halothane

BARRY L. ZIMMERMAN, M.D.,* AND JACK LORD, M.D., MAJ, MC†

Inhalation of a volatile anesthetic drug in the form of liquid or saturated vapor is a rare anesthetic catastrophe.1–3 Such incidents have occurred with both concentration-calibrated vaporizers (e.g., Fluotec®, Fluomatic®, etc.)1 and flowmeter-controlled devices (e.g., Vernitrol®, Copper L’ettle®, etc.)2,4 and are related to faulty technique. We recently observed the introduction of liquid halothane into the fresh-gas delivery tubing of an anesthesia machine as the result of an error in technique combined with the use of inappropriate materials in the circuit.

REPORT OF INCIDENT

During a routine preanesthetic check of an anesthesia machine (Ohio Model 2000, Ohio Medical Products, Madison, Wisconsin), we found that the on-off valve of the sidearm Vernitrol vaporizer had been left open overnight, with a flow of 20 ml/min through the vaporizer, which contained 100 ml halothane. After the flowmeter was turned off, the valve closed, and a flow of 5 l/min oxygen through the main oxygen flowmeter began, a strong odor of halothane was apparent from the system. We then noticed about 5–6 ml of clear liquid collected in the transparent polyvinyl chloride (PVC) fresh-gas delivery tubing. When poured from the tubing into a gauze sponge, the liquid evaporated quickly, with the strong odor of halothane.

* Assistant Clinical Professor, Department of Anesthesiology, University of California, San Diego.
† Staff Anesthesiologist, Eisenhower Army Hospital, Fort Gordon, Georgia.

Received from the Brooke Army Medical Center, Fort Sam Houston, Texas, and the University of California Medical Center, 225 Dickinson Street H770, San Diego, California 92103. Accepted for publication December 9, 1979.

Address reprint requests to Dr. Zimmerman.

The opinions represented herein are solely those of the authors, and do not represent policy of the Department of Defense, Department of the Army, Army Medical Department, or the Brooke Army Medical Center.

ADDITIONAL STUDIES

A similar anesthesia machine was later set up with a clean 4-foot length of PVC tubing (Bentley IT-200, Bentley Laboratories, Inc., Irvine, California) connecting the common gas outlet to a Mapleson D-type patient circuit. The valve of the sidearm vaporizer was opened and a flow of 20 ml/min was directed through the vaporizer, which contained about 100 ml halothane. Room temperature varied between 18 and 20 C. Within 30 min, droplets of liquid were seen condensing on the walls of the tubing. After two hours, more than 2 ml of liquid had accumulated. By four hours, 4–6 ml were present. Most of the liquid evaporated rapidly when an oxygen flow of 5 l/min was begun. The identity of the volatile component as halothane was confirmed by gas chromatography. The residue, an oily liquid, was identified by the technical branch of Bentley Laboratories, Inc., as dioctyl phthalate, a plasticizer, which had apparently dissolved in the liquid halothane.

Similar results were obtained using enflurane instead of halothane, with other Ohio machines with similar vaporizers (Vernitrols), and with a Model 300 Fortrend® machine equipped with a Copper Kettle #1 vaporizer (Foregger Company, Division of Air Products and Chemicals, Inc., Smithtown, New York).

Halothane would also apparently accumulate if conductive rubber tubing were used in place of the PVC, but most of the halothane was absorbed, with swelling and distortion of the walls of the tubing, and could not be recovered as the liquid. However, liquid accumulation was not observed when a length of bent glass tubing was substituted for the PVC, or when a length of silicone rubber (Silastic®, Dow Corning Corp., Midland, Michigan) was used.

DISCUSSION

The absorption of volatile anesthetics by conductive rubber is well known.4 However, it is not immediately
obvious why condensation into the liquid phase should take place under the circumstances described here. If, as is almost invariably the case, the vaporizer operates at a temperature below ambient, one would expect a saturated vapor to become less saturated as it emerged into the (relatively) warm exterior tubing and circuit. Supersaturation and condensation would not be expected. That something more is involved than a simple phase change is indicated by the failure to condense on glass or silicone. Of the commonly used plastics, PVC is probably the most soluble with halothane, due in a great part to the presence of a very soluble plasticizer. It is probable that what is being observed is an actual dissolution of the halothane in the PVC, and vice versa. This would indicate that PVC is not an appropriate material to use in a circuit through which volatile anesthetics will be administered. If an alternative to conductive rubber is desired, polyethylene (which does not contain a similar plasticizer) or gum rubber might be suitable. Silicone could also be used, but its extreme flexibility makes it prone to kinks.

The consequences of contaminating an anesthesia system with volatile drugs have been reported. In the situation we describe here, use of published formulas to calculate a "dose" of anesthetic for a closed system allows the construction of a "worst case" in these circumstances. If 10 ml of liquid halothane were in the tubing, and a standard adult circle system was used with very low flows (approaching a closed system), and no other inhalational drug was being used, exhaled concentrations in excess of 5 per cent should be produced for the first minute of use. Other problems range from the physical trauma of blowing liquid halothane down an endotracheal tube with an oxygen "flush" (especially if a low-volume pediatric system is being used) to the psychic effects of "pre-oxygenating" an awake patient with high inhaled concentrations of halothane. This report illustrates one more way in which such incidents may occur, and emphasizes the importance of a meticulous approach to the handling of equipment, including the preanesthesia equipment check.

The authors thank Dr. Ronald Dueck for performing the gas chromatography, and Drs. Douglas Magic and John Wheeler for their very helpful comments.

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Anesthesiology
52:513–516, 1980

Ultrasonic Localization of the Lumbar Epidural Space

RANDALL C. CORK, M.D., PH.D.,* JOSEPH J. KRYC, M.D.,† ROBERT W. VAUGHAN, M.D.‡

Ultrasound imaging applications in anesthesiology have been limited. Barash et al. and Rathod et al. used ultrasound to assess effects of volatile anesthetics on cardiovascular hemodynamics. Other medical specialties employ ultrasound for real-time imaging to guide needle placement for aspiration of renal cysts, amniocentesis, and pericardiocentesis, and to measure the diameter of the spinal canal.

* Chief Resident.
† Resident.
‡ Associate Professor.

Received from the Department of Anesthesiology, University of Arizona, Health Sciences Center, Tucson, Arizona 85724. Accepted for publication December 17, 1979. Presented at the annual meeting of the American Society of Anesthesiologists, October 1979. Address reprint requests to Dr. Cork.

An extension of ultrasound scanning in anesthesiology may be identification of the epidural space for correct needle positioning. The purpose of this communication is to demonstrate the use of ultrasound for landmark identification for lumbar epidural anesthesia.

METHODS AND MATERIALS

This study was approved by the Arizona Health Sciences Center Human Subjects Committee. All patients gave informed consent. Thirty-six patients, 22 male and 14 female, scheduled for procedures involving epidural needle puncture were studied. Real-time scanning was performed with an Air-Shields Sono Scan® Ultrasonic Scanner (Model SSD-202).