Clinical Implications of Halothane Contamination of the Anesthetic Circle

MICHAEL H. M. DYKES, M.B., B.CHIR.,* AND L. HANS LAASBERG, CH.E.†

Although a sensitized individual can develop hepatitis after a 5-minute exposure to 1,000 to 2,000 parts per million (ppm) halothane, or after a 5-hour exposure to the concentrations of the drug which can be present in operating suites,¹ we currently have no knowledge of the lowest concentrations of this drug to which such a patient might react. During administration of an anesthetic, halothane concentrations with an overall average value of 10 ppm (maximum 49 ppm near the anesthetist’s nose) have been measured in operating rooms, and 0.5 ppm (maximum 4 ppm) in adjacent corridors;² and a mean concentration of the drug of 67 ppm has been recorded within 25 cm of the patient’s head, with an occasional value as high as 290 ppm.³

By contrast, when an artificial anesthetic circle was exposed to 1.45 per cent halothane for 6 hours, approximately 3,000 ppm halothane were released for approximately 30 minutes from the rubber tubing and bag while a 500 ml/min oxygen flow continued.⁴ As substantial quantities of several inhalation anesthetics can be absorbed by an artificial anesthetic circle, replacement of the entire circle, including the soda lime, has been recommended when a succeeding patient is suspected of being sensitized to the agent to which the circle has just been exposed.⁵

Because of the obvious serious clinical implications of these data, we measured halothane washout curves from a standard anesthetic semiclosed circle system.

* Assistant Professor of Anaesthesia, Harvard Medical School; Associate Anaesthetist, Beth Israel Hospital.
† Principal Associate in Anaesthesia (Chemical Engineering), Harvard Medical School and Beth Israel Hospital.

Received from the Department of Anaesthesia, Harvard Medical School, and the Beth Israel Hospital, Boston, Massachusetts 02215. Supported in part by Grant GM 15904 from the National Institute of General Medical Sciences.

METHODS

An artificial “lung” (5-liter anesthesia bag) was ventilated manually with halothane for 30 minutes—4 per cent for 2 minutes, 2 per cent for 8 minutes, and 1.5 per cent for 20 minutes—by means of a standard Ohio anesthesia circle (2,200-gm soda lime absorber) using a 5-l/min oxygen flow. Halothane washout curves were then obtained with the same oxygen flow, after the artificial “lung” and the breathing bag had been filled with 100 per cent oxygen and emptied through the “pop-off” valve twice, under three conditions: 1) The artificial “lung” was changed (four curves). 2) The artificial “lung” and the rubber goods (two 32-inch lengths of rubber breathing tubing and a 3-liter anesthesia bag) were changed (four curves); in this group, two additional curves in which the investigators acted as the artificial “lung” during washout were included. 3) The artificial “lung,” the rubber goods, and the soda lime were changed (four curves).

Gas samples obtained from the artificial “lung” were analyzed on a Hewlett-Packard Gas Chromatograph.⁶ The responses were linear, and accuracy was within ±0.5 per cent. All equipment used contained less than 5 ppm halothane before starting. The washout curves commenced 3 to 5 minutes after completion of exposure to halothane, and were terminated either an hour later or when halothane concentrations fell below 5 ppm.

RESULTS

The halothane washout curves are depicted in figure 1. When only the artificial “lung” was changed after the exposure period, the initial washout concentrations ranged from 491 to 1,033 ppm (mean 672 ppm), and fell to 218 to 468 ppm (mean 329 ppm) 5 minutes later. When all the rubber goods were changed after the exposure period, the initial washout concentrations ranged from 427
to 501 ppm (mean 454 ppm), and fell to 86 to 115 ppm 6 minutes later. The two curves obtained for the investigators were similar to, but lower than, those obtained with the artificial "lung." When all the rubber goods and the soda lime were changed after the exposure period, the initial washout concentrations ranged from 45 to 99 ppm (mean 77 ppm) and fell to 26 to 52 ppm 5 minutes later. All curves continued to fall in an exponential manner.

**Discussion**

We conclude that after an anesthetic circle has been used to administer halothane for 30 minutes, it contains enough halothane to deliver to a succeeding patient a substantial proportion of the quantity which can cause hepatitis in a sensitized individual. The contamination is markedly reduced, but not eliminated, when the rubber goods and soda lime are changed after the exposure period. We believe that such residual contamination results from adsorption of the halothane onto metal surfaces.

Under actual clinical conditions, it is anticipated that this residual contamination would be reduced even further by the washout period which usually terminates a clinical anesthetic, although presumably it would be increased by increasing the duration of exposure of the anesthetic circle beyond 30 minutes.

Little is known of the levels of halothane which can exist in operating rooms between the administration of anesthetics, and to which a subsequent patient must be exposed prior to the induction of his anesthetic. It can be assumed, however, that as increasingly effective measures are taken to reduce "pollution" in operating rooms, these levels will be reduced substantially, rendering contamination of the anesthetic circle a relatively more important source of drug for producing a sensitization reaction.

On the basis of our data, therefore, we suggest that any patient who has become sensitized to halothane be anesthetized with an anesthesia machine which has not recently been exposed to the drug, until more is known concerning the concentrations of halothane necessary to produce hepatocellular destruction in such a patient.

**References**