Solubility of I-653, Sevoflurane, Isoflurane, and Halothane in Plastics and Rubber Composing a Conventional Anesthetic Circuit

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This study defines some characteristics of a standard anesthetic circuit that may impede anesthetic induction and recovery with I-653, sevoflurane, isoflurane, and halothane. Partition coefficients for anesthetic circuit components (masks, bellows, bags, airways, and circuit tubes) consistently ranked halothane > isoflurane > sevoflurane > I-653, suggesting a reverse order of washin and washout rates for an anesthetic circuit constructed from similar components. Consistent with this prediction, the concentrations of I-653 increased and decreased more rapidly than those of the other agents at any flow rate during washin (0.5, 1, or 2 L/min gas inflow rates) or washout (1, 3, or 5 L/min) in a conventional anesthetic circuit. The rates of change in I-653 concentration closely approximated the maximal possible theoretical rates.

Our results suggest that absorption of I-653 by circuit components or soda lime should not hinder induction of or recovery from anesthesia.

Key Words: ANESTHETICS, VOLATILE—halothane, I-653, isoflurane, sevoflurane. EQUIPMENT, ANESTHETIC CIRCUIT SYSTEM—closed, low flow. SOLUBILITY—partition coefficients.

I-653 is an inhaled anesthetic with a blood/gas partition coefficient of 0.42 (1), which indicates that it can produce rapid induction of and recovery from anesthesia. Rats anesthetized with I-653 recover more rapidly than those anesthetized with sevoflurane, isoflurane, or halothane (2).

Because I-653 is expensive to use, it likely would be applied in a low-flow or closed-circuit absorption system. Six factors govern the rate at which anesthesia can be induced with a low-flow system: the flow into the system; the volume of the system; the uptake of anesthetic by the patient; the concentration of anesthetic in the delivered gases; the extent to which circuit components absorb anesthetics; and the extent to which anesthetic is degraded by soda lime. Might absorption or degradation of I-653 by circuit components hinder the development of an anesthetizing concentration? To examine this question, we studied the solubility of I-653, isoflurane, halothane, and sevoflurane in plastics found in conventional anesthetic circuit components, and the impact of flow rate, absorption, and degradation on the increase and decrease of I-653 relative to other volatile anesthetics in a conventional anesthetic circuit.

Methods

First, we compared the solubility of I-653, sevoflurane, isoflurane, and halothane in anesthesia circuit components. In addition, we examined the washin and washout rates of these anesthetics delivered to a conventional anesthetic circuit system at various flow rates.

Solubility of Anesthetics in Circuit Components

We determined plastic/gas and rubber/gas partition coefficients of each circuit component with a modification of a method used previously (3). The density of a collection of thin pieces of each component was determined by adding a known mass of thin pieces of component to a 75-ml volumetric flask of known mass, filling the flask precisely to the 75-ml line with distilled water, and determining the combined mass.

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