

Laboratory Note

Effects of Hypothermia on Halothane MAC and Isoflurane MAC in the Rat

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MAC was determined in tracheotomized rats for halothane (5 rats) and isoflurane (5 rats) at 37, 32, and 27 C. Rectilinear decreases in MAC occurred with both agents. The change with halothane (4.82 per cent per degree) did not differ significantly from that seen with isoflurane (5.28 per cent per degree). We conclude that animals anesthetized with isoflurane conform to the pattern of linear MAC decreases with decreases in temperature described for other anesthetics. The MAC decrease for isoflurane is greater than those found with fluroxene, ether, or cyclopropane. (Key words: Anesthetics, volatile: isoflurane; Anesthetics, volatile: halothane; Hypothermia; Potency, anesthetics: MAC.)

ANESTHETIC REQUIREMENT (*i.e.*, MAC) is influenced by changes in body temperature. Considerable data describing anesthetic potency in the normothermic animal, including man, are available, but there is only limited information concerning potency changes with hypothermia.¹⁻³ Such changes are of both clinical and experimental interest. Many measurements of the pharmacologic or biochemical effects of anesthetics *in vitro* are made at subnormal temperatures. Evaluation of the results obtained requires an estimate of anesthetic potency at those temperatures.

An estimate of the potency of isoflurane (Forane[§]) at reduced body temperatures has not been reported. Furthermore, the data

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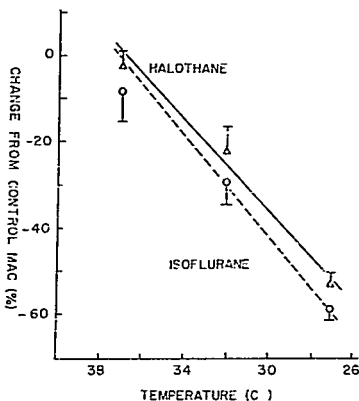


FIG. 1. Effects of temperature on MAC during halothane (Δ) and isoflurane (O) anesthesia in tracheotomized rats breathing spontaneously. Mean values \pm SE at temperatures investigated are shown.

available for halothane potency changes with hypothermia in the rat¹ are based on inspired halothane measurements which may not accurately reflect alveolar and brain anesthetic partial pressures.⁴ We therefore determined isoflurane MAC and halothane MAC at normal and reduced body temperatures in the rat.

Methods and Materials

Five 375 ± 25 -g male Sprague-Dawley rats were anesthetized with halothane in oxygen and tracheotomized. Five additional rats were treated similarly using isoflurane in oxygen for anesthesia. Minimum alveolar concentra-

TABLE I. Halothane and Isoflurane MAC Values* in Tracheostomized Spontaneously-breathing Rats at Various Body Temperatures

	Control MAC 37 ± 0.5 C	Experimental MAC Values			Slope Values (Percentage Decrease in MAC/ Degree Decrease in Body Temperature)
		27 ± 0.5 C	32 ± 0.5 C	37 ± 0.5 C	
Halothane	0.88 ± 0.02(5)	0.41 ± 0.01(5)	0.69 ± 0.04(4)	0.81 ± 0.06(4)	4.82
Isoflurane	1.20 ± 0.05(5)	0.50 ± 0.04(5)	0.84 ± 0.04(5)	1.17 ± 0.06(5)	5.28

* All MAC values are reported as means ± SE. Numbers in parentheses are the numbers of animals studied.

tion (MAC) of anesthesia was determined according to the modified method of White *et al.*⁴ After control MAC values were determined at 37 C, the animals were cooled to 27 C, then rewarmed to 32 C and then to 37 C. Cooling or warming was achieved by surrounding the anesthetic chambers with ice or heating pads. MAC values were re-determined at each temperature. Rectal temperatures were maintained within ±0.5 C at each temperature during MAC determinations. End-expiratory gas samples were obtained for infrared analysis of halothane, isoflurane, and carbon dioxide concentrations. Carbon dioxide levels were used to indicate the adequacy of our end-expiratory gas sampling. Linear regression analysis for arithmetic coordinates were used to estimate the effect of hypothermia on MAC.

Results

Halothane and isoflurane MAC values at 27 and 32 C were reduced in rectilinear fashion from initial values at 37 C (table I, fig. 1). MAC obtained at 37 C on rearming following hypothermia was not significantly different from the original MAC at 37 C. There was no significant difference between halothane and isoflurane in percentage reduction in MAC per degree reduction in body temperature (4.82 versus 5.28 per cent per degree).

Discussion

Our values for the reduction in halothane MAC with hypothermia are less than those

previously found in the rat.¹ This difference probably resulted from our use of end-tidal rather than inspired anesthetic concentrations. Our results in rats are close to those obtained in dogs where end-tidal samples were used.^{2,3}

Our data show that isoflurane conforms to the pattern described for other anesthetics of linear decreases in MAC with decreases in temperature. Lowering body temperature 10 C in rats caused an isoflurane MAC reduction that approximately equalled the MAC reduction for halothane. Both these agents show greater changes in potency than occur with fluroxene (4.2 per cent per degree), ether (3.7 per cent per degree), or cyclopropane (2 per cent per degree).³

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