Effect of Hypothermia in Dogs on Anesthetizing and Apneic Doses of Inhalation Agents

Determination of the Anesthetic Index (Apnea/MAC)

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Moderate hypothermia in dogs rectilinearly decreased anesthetic requirements for cyclopropane, diethyl ether, fluoroene, halothane and methoxyflurane. The greatest reductions (52 and 53 per cent) occurred with the most lipid-soluble agents, halothane and methoxyflurane, and the smallest (29 per cent) with the least soluble, cyclopropane. Reductions with ether and fluoroene were 42 and 37 per cent. More profound hypothermia to 22–24° C. led to further reductions, suggesting that between 18–21° C. cold itself would be sufficient for anesthesia.

Moderate hypothermia also decreased the concentration of anesthetic required to produce apnea, so that the anesthetic index (apneic concentration/anesthetic concentration) did not change significantly with decrease in temperature except for diethyl ether, whose index rose significantly over 10° C. At normothermia there was a significant difference between the index for cyclopropane (2.4) and that for methoxyflurane (3.4), but no significant difference existed among the other agents.

Moderate hypothermia reduces anesthetic requirements. This is apparent clinically and recently has been measured in the dog. Eger et al.† reported a rectilinear decrease between 38 and 28° C. of the minimum alveolar concentration (MAC) of halothane and cyclopropane necessary to prevent gross movement in a dog when the tail was clamped. MAC of halothane at 28° C. was 50 per cent less, and MAC of cyclopropane was 25 per cent less than the normothermic values, respectively.

Ventilatory responsiveness to hypercapnia and hypoxia is also reduced by moderate hypothermia. We have shown that during constant depth halothane anesthesia in dogs at 27–28° C., the slope of the ventilatory response to carbon dioxide falls to 25 per cent of the normothermic slope, and the ventilatory response to hypoxia is reduced to one-fifth the normothermic response. Despite this depression, resting spontaneous ventilation at 27° C. is adequate to maintain arterial carbon dioxide tension at or below normothermic levels. This suggests that nonchemical ventilatory drives are active at lower temperatures. The nature of these drives is unknown, but the thermal stimulus of a cold environment may play a role.

Can these drives sustain ventilation at deeper levels of anesthesia and are they more or less resistant in the cold animal to the respiratory depressant effects of anesthetics? We have attempted to study this by determining whether more or less anesthetic agent is required to produce respiratory arrest at lower temperatures. Since this inquiry must take into consideration the reduced anesthetic requirements during hypothermia, an “anesthetic index” was calculated for each temperature studied. The index is the alveolar concentration of anesthetic required to produce apnea divided by the concentration required for anesthesia. Comparison of indices at different temperatures should disclose whether proportionately more or less agent is needed to produce respiratory arrest and yields information on the relative respiratory depressant effects of the agents. We have determined the anesthetic indices for cyclopropane, diethyl ether, halothane and methoxyflurane at normal temperatures, at 32° and at 27° C. We have also

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