

tid occlusion were measured before and during anesthesia with cyclopropane, halothane, Narkotal (isopropyl- $\beta$ -bromallyl-N-methylmalonyl-carbamide sodium), 25-27 mg./kg., or after intramuscular administration of morphine sulfate, 1-1.5 mg./kg. *Results:* "Light" cyclopropane anesthesia caused no change or a slight increase in the arterial pressure, reduced the blood flow and increased the calculated vascular resistance in the hind limb. The pressor response to central stimulation was reduced and sometimes changed to a depressor one. The cholinergic vasodilating response persisted. Response to carotid occlusion did not change or decreased slightly. "Deep" cyclopropane anesthesia caused variable changes in the arterial pressure, markedly reduced the blood flow and increased the vascular resistance. All responses to central stimulation and carotid occlusion were abolished. Halothane anesthesia, depending on the "depth," reduced or abolished the pressor response to central stimulation and carotid occlusion. The cholinergic vasodilating response was not altered significantly. Narkotal, in the dose employed, produced "light" narcosis. It reduced the arterial pressure, blood flow and the pressor response to central stimulation and carotid occlusion. The cholinergic vasodilating response was not altered significantly. Morphine produced sedation. It did not significantly change the arterial pressure but reduced the blood flow and increased the vascular resistance. Pressor and cholinergic vasodilating responses to central stimulation were not altered. *Conclusions:* These observations suggest that anesthesia generally suppresses the excitatory vasomotor mechanisms, confirming the concept of depressant action of halothane and barbiturates, but denying the thesis that the circulatory effect of cyclopropane is due to its selective sparing action on these mechanisms. These results also indicate that the sympathetic cholinergic vasodilating mechanisms in the hypothalamus can be activated during sedation and "light" anesthesia. (Supported by USPHS grant 5 TI HE-5614-03 and the Commonwealth Fund.)

**Effect of Postural Variations on Anatomic Dead Space Before and After Atropine.**  
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*esthesiology, Columbia-Presbyterian Medical Center, New York City.* The observation (Tomlin, P. J., Conway, C. M., and Payne, J. P.: *Lancet* 1: 14, 1964) that patients developed hypoxemia after atropine and before operation suggested that atropine acted by markedly increasing the dead space. In addition, interpretation of the data accumulated by many investigators depends upon whether the dead space is fixed or variable. Among the factors which influence dead space are the effects of posture and belladonna drugs. While the effects of posture and of atropine have been measured independently, it seemed reasonable to examine the combined effects of posture plus atropine. *Methods and Results:* Eight healthy male subjects were studied in the supine, sitting, right and left lateral positions before and 20 minutes after the intramuscular injection of 0.8 mg. atropine. Pilot studies revealed that 0.8 mg. atropine produced a greater dead space change than 0.5 mg. atropine and the same change as 1.2 mg. atropine. Anatomic dead space was measured using the Fowler single-breath technique with nitrogen as the indicator gas. The method is based upon the simultaneous measurement of expired gas volume and expired  $N_2$  content following the change from breathing air to inhaling 100 per cent oxygen. There was no statistically significant difference in the tidal volume measured in the various positions before or after atropine administration. There was no significant difference among the dead spaces in the various positions before atropine administration. However, atropine administration caused a significant increase in anatomic dead space of about 25 per cent greater than the control. We were curious to determine if the observed 25 per cent increase in anatomic dead space would cause a clinically significant fall in arterial oxygen saturation. Twenty patients in good physical condition were studied. Control arterial blood samples were obtained from semi-recumbent patients, by percutaneous arterial puncture from the brachial artery into 10 ml. heparinized syringes. The blood was allowed to fill the syringe under its own pressure for one to two minutes, and during this period the patient was encouraged to relax and breathe naturally. This procedure was re-

peated 20 minutes after atropine premedication and the arterial samples analyzed for arterial oxygen saturation. All the control arterial-blood measurements were greater than 95 per cent saturation. No significant change occurred in the arterial oxygen saturations after atropine.

Since dead space increases with lung volume, it is well when determining the effect of pharmacologic agents on the dead space to insure that the observed changes were not produced by lung volume increases. The data indicate that no significant volume changes occurred in these experiments. *Conclusion:* We were unable to demonstrate any significant difference in either tidal volume or anatomic dead space with change in body position. The injection of 0.8 mg. atropine caused a 25 per cent increase in anatomic dead space regardless of body position. Premedication with atropine was not followed by a change from the control arterial oxygen saturation measurements.

**Minimum Alveolar Concentrations of Methoxyflurane, Halothane, Ether, Fluoroxene, Cyclopropane and Nitrous Oxide in Man.** LAWRENCE J. SAIDMAN, M.D., EDWIN S. MUNSON, M.D., EDMOND I. EGER, II, M.D., and ARTHUR A. BABAD, M.D., *Department of Anesthesia, University of California Medical Center, San Francisco, California.* The minimum alveolar concentrations (MAC) of halothane and fluoroxene required to prevent movement in response to a skin incision have been previously determined (Saidman, L. J., and others: *ANESTHESIOLOGY*, 25: 302, 1964; Munson, E., and others: *ANESTHESIOLOGY*, 26: 143, 1965). Seventy per cent nitrous oxide reduced the MAC for halothane and for fluoroxene. MAC values obtained in these studies without nitrous oxide were—halothane 0.74 per cent and fluoroxene 3.4 per cent, while with nitrous oxide added they were—halothane 0.23 per cent and fluoroxene 1.2 per cent. If it may be assumed that the effect of nitrous oxide was additive to that of the other agents, then a MAC of 101 per cent for nitrous oxide may be predicted. This study was performed to determine the MAC's for methoxyflurane, ether, and cyclopropane in man. *Methods:* The methods for ether and methoxyflurane

studies were similar to those of the fluoroxene study. Predetermined alveolar tensions of the agent being studied were held constant in surgical patients for a sufficiently long period to insure a brain tension of at least 95 per cent of that in the alveoli. When the skin incision was made the patient was observed for movement. MAC was defined as that concentration below which 50 per cent of the patients moved and above which 50 per cent failed to move. Inspired cyclopropane concentrations corrected for dilution by water vapor were measured rather than alveolar concentrations. This was considered valid since uptake of cyclopropane at the time of incision was low and balanced in part by an R/Q of less than one. *Results:* MAC for cyclopropane was 9.2 per cent, for ether 2.6 per cent, and for methoxyflurane 0.16 per cent, although more recent studies in our laboratory would indicate an ether MAC closer to 2.0 per cent. These results along with those for halothane, fluoroxene, and nitrous oxide illustrate the relation between anesthetic potency and lipid solubility. The product of these two factors for each agent studied varies from 106 for cyclopropane to 174 for diethyl ether, a remarkably low range considering that these products are derived from anesthetic concentrations that vary over a 630 fold range. If this relation holds true for all general anesthetics, the average of these products (146) may be used to predict the approximate potency of any new anesthetic, given the oil solubility. *Conclusions:* The primary importance of MAC is in the establishment of what we believe are equipotent doses of anesthetic agents. With these doses comparative studies may be made of the circulatory, respiratory, metabolic or other effects of anesthetics. Thus 0.16 per cent methoxyflurane may be compared with 3.4 per cent fluoroxene, each of these being equivalent anesthetic doses. (Supported in part by USPHS Grant 5R01 HE07946, 5-K3-GM-17, and 5T1-GM-63).

**Halothane, Peripheral Vascular Resistance, and Respiratory Acidosis.** RICHARD M. SCHLOBOUM, M.D., F. NORMAN HAMILTON, B.S., PETER J. TOMLIN, M.B., LUCIEN E. MORRIS, M.D., *Anesthesia Research Laboratories, Providence Hospital, Seattle, Washington.* Pe-