

remained effective or increased in effectiveness following reserpine. Although methoxamine is theoretically an amine oxidase inhibitor, there is no direct report concerning this in the literature. In summary, epinephrine, norepinephrine, and phenylephrine are all effective in combating the hypotension which follows the injection of reserpine. This is also true of methoxamine. This may be clinically useful in treatment of hypotension appearing in patients under anesthesia who have been on reserpine therapy. Although the cause of the above hypotension is not definitely known, one possibility in the light of the effect of reserpine on epinephrine and norepinephrine might be stated thus: The response of the body to depression of blood pressure is dependent at least in part on the release of epinephrine and norepinephrine. In the patient who has received reserpine, the response to depression of blood pressure caused by anesthetic agents may be impossible because of the scarcity of these amines. If this is correct then one logical way to correct the hypotension would be to supply the necessary amount of the missing catechol amines or some appropriate substitute.

**Electromyography of the Diaphragm.** B. RAYMOND FINK, M.D., AND S. H. NGAI, M.D. *Department of Anesthesiology, Columbia University College of Physicians and Surgeons, and the Anesthesiology Service, The Presbyterian Hospital, New York, N. Y.* This investigation into the electrical activity of the diaphragm was planned on the premise of a definite relation between the integrated electromyogram and the tension of skeletal muscle (*J. Physiol.* 123: 214, 1954). The object was to explore the usefulness of the integrated electromyogram as a measure of adequacy of respiration. Decerebrate cats were subjected to rebreathing of oxygen, to inspiration against increased resistance, to partial myoneural block and to graduated doses of intravenous pentobarbital. Airway pressure, air flow rate, tidal volume, and the integral of diaphragmatic electrical activity were recorded continuously with a cathode ray oscillograph. The integral activity rate was averaged over each period of inspiratory flow, and the average used as the index of diaphragmatic activity in each breath.

Activity was found throughout the diaphragm and when changes in the electrical activity rate occurred as a result of a respiratory stress, the changes were proportionately the same in all phases of an inspiration and in all parts of the muscle. When CO<sub>2</sub> was allowed to accumulate during rebreathing of oxygen, it was found that the rate of electrical activity was proportional to air flow rate and also to tidal volume. A similar linear relationship between electrical activity rate and tidal volume was found during the onset of and recovery from partial paralysis induced by succinylcholine. When the inspiratory flow resistance was increased, the electrical activity rate increased linearly with the added load. However, in this case, the duration of inspiration was always prolonged, whereas in rebreathing it was shortened. The effect of pentobarbital was to cause a prolonged inspiratory discharge, but at a decreased rate of activity. If the animal breathed spontaneously, the discharge rate recovered relatively rapidly over a period of five minutes, probably as a result of carbon dioxide accumulation. When carbon dioxide retention was prevented by means of artificial ventilation, a much slower recovery of activity took place. In the latter group of animals, the integrated electrical activity rate of the diaphragm proved remarkably sensitive to small doses of pentobarbital. Carbon dioxide retention, increased inspiratory resistance, muscle relaxants, and anesthetic drugs each produced a distinctive effect on the integrated electrical activity of the diaphragm. The clinical usefulness of these observations is being explored.

**Prolonged Maintenance of Coronary Sinus Catheters in Dogs for the Study of Myocardial Metabolism.** S. J. GALLA, M.D., A. W. R. WILLIAMSON, F.R.C.S., AND L. D. VANDAM, M.D. *Division of Anesthesia, Department of Surgery, Peter Bent Brigham Hospital and Harvard Medical School, Boston, Mass.* During investigation of the effects of anesthetic agents on the myocardial metabolism of dogs it was found necessary to develop a method of sampling blood from the coronary sinus in both the conscious and anesthetized states. Recent work (Rudolph, A. M., and Paul, M. H.: *J. Appl. Physiol.* 10:327, 1957) involving chronic catheterization of the pulmonary and

systemic circulations suggested the feasibility of maintaining catheters in the coronary sinus as well as the great vessels for prolonged periods of time. Healthy mongrel dogs weighing 15–20 kg. were anesthetized with ether. A right thoracotomy was performed through the bed of the fourth rib exposing the right ventricle, right atrium and great vessels. A 12 gauge, thin-walled, metal trocar was inserted under the control of a purse-string suture into the right ventricle and a 60 cm. length of soft, polyvinyl tubing (I.D. 0.047 inch and O.D. 0.081 inch) was introduced into the pulmonary artery. Similarly, aiming at a point about 1 cm. anterior to the entrance of the inferior vena cava, a catheter was inserted for a distance of 1.5–2 cm. into the coronary sinus through the right atrium. For sampling of arterial blood, catheters were inserted either into the brachiocephalic trunk through the right internal mammary or subclavian artery, or into the aorta through the left ventricle after the heart had been lifted 90 degrees. The catheters were sutured with silk to the myocardium, pericardium and thoracic cage before being passed beneath the scapula and through the skin of the neck. They were fastened externally with adhesive tape which encircled the neck several times. The catheters were immediately filled with 1 ml. of 0.5 per cent heparin solution and plugged with blunt 18 gauge needles fitted with Luer caps. The ends of the catheters were protected in a folded towel which encircled the neck and fastened with safety pins. The catheters were flushed with saline daily and refilled with 0.5 per cent heparin. During operation the position of each catheter was verified by palpation and observation of the color of the blood. Postoperatively, position was confirmed by analysis of the oxygen content of the blood samples drawn simultaneously. When dogs were sacrificed, postmortem examination of the heart further established the position of each catheter. In 10 dogs coronary sinus catheters were maintained in a patent state from 5 to 37 days with an average duration of 16 days. Arterial and pulmonary artery catheters could be maintained for a much longer time. In a number of instances clotting was temporarily corrected by injection of a fibrinolytic enzyme, Actase. Irreversible clot-

ting within the lumina or formation of fibrinous deposits on the outside occurred eventually in all of the coronary sinus catheters. In 9 fasting dogs following a rest period of 30–60 minutes duplicate analyses of blood gases, pH and hematocrit were performed on samples drawn simultaneously from the aorta, coronary sinus and pulmonary artery. Average arterial values were as follows: whole blood carbon dioxide content, 17.59 mM/l. (14.80–18.87); calculated  $p\text{CO}_2$ , 33.0 mm. of mercury (30–38); pH, 7.39 (7.32–7.44); hematocrit, 43 per cent (39–51); oxygen content, 17.35 volumes per cent (15.76–21.13); oxygen capacity, 19.00 volumes per cent (16.81–22.60); and oxygen saturation, 91.4 per cent (86.0–93.9). The coefficient of myocardial oxygen extraction averaged 79 per cent, and the coefficient of total body oxygen extraction averaged 33 per cent. We believe this technique will overcome some of the problems inherent in metabolic studies performed on animals wherein anesthesia may be a modifying factor.

**The Effect of Anesthesia on Thyroid Activity in Humans.** NICHOLAS M. GREENE, M.D., AND IRA S. GOLDBERG, M.D. *Section of Anesthesiology and Department of Surgery, Yale University School of Medicine, New Haven, Conn.* Circulating levels of thyroid hormones were determined as follows: each patient was given an oral tracer dose of  $\text{I}^{131}$  48 hours prior to operation. On the day of operation, venous blood samples were drawn prior to preanesthetic medication, after medication prior to anesthesia, following the induction of anesthesia prior to surgery, and 50 to 100 minutes after the start of surgery. Each blood sample was centrifuged and the radioactivity in 2 ml. of serum was determined in a scintillation well detector following which the amount of radioactivity associated with protein-bound iodine (PBI) was determined. PBI was obtained by passage of serum through an ion-exchange column. Results were tabulated in terms of a conversion ratio (C.R.) calculated by dividing the net counts of  $\text{PBI}^{131}$  in 2 ml. serum by net counts of  $\text{I}^{131}$  in 2 ml. serum and multiplying the result times 100. Eighteen patients unselected except for elimination of those with thyroid disease were studied. All but 2 were males. Premedica-