promises the performance of the isolated heart more severely in the presence of elevated arterial pressure. The heart is still able to increase its volume output albeit at increased filling pressures. If the observed phenomenon applies also to the heart *in situ*, the fall in arterial pressure clinically observed during halothane anesthesia may be beneficial in that it may enable the heart to maintain an adequate output.

Rapid Blood Ether Determinations Using Gas Chromatography. JOHN M. BAKER, M.D., and BENTON D. KING, M.D., *Department of Anesthesiology, School of Medicine, State University of New York at Buffalo.* Renewed interest in the uptake and distribution of anesthetics by the body has pointed up the need for analytical methods capable of rapidly and accurately estimating the anesthetic concentration of multiple serial blood samples. Previously described procedures for the measurement of diethyl ether in blood have suffered from inaccuracy or prolonged and complicated manipulations. For this reason, a method for the measurement of blood ether was developed using gas chromatography that is simple, rapid, and accurate.

To minimize inaccuracy, solvent extraction was chosen in preference to manometric extraction or direct injection of the blood into the chromatograph. Because of its availability and solubility characteristics, carbon tetrachloride was used in a one-to-one ratio with blood, which was drawn and handled anaerobically until extraction with the solvent. For this purpose, 1 ml. of carbon tetrachloride was placed in a 3 or 5 ml., stoppered vial or Vacutainer. An equal amount of blood was withdrawn from the patient into a 2-ml. syringe provided with a Chaney adapter. The blood was transferred directly into the vial by attaching a needle to the syringe and puncturing the stopper. The vial was shaken gently for several minutes and then centrifuged stopper end downwards at high speed. The solvent layer next to the stopper was removed anaerobically using a microliter syringe and needle assembly. A 10 microliter sample was injected into the chromatograph for analysis. A Beckman model GC-2 gas chromatograph with a Carbowax 400 column material was used to achieve separation of the ether from the carbon tetrachloride. This instrument employs a thermal conductivity detector whose output is fed to a potentiometric strip chart recorder. The areas under the signal peaks as written by the recorder in response to ether flowing through the detector are a linear function of the amount of ether by weight in each sample; and when compared with the areas obtained with injection of known amounts of ether, the concentration of ether in the sample can be estimated within 1 per cent. When blood was extracted with carbon tetrachloride, a 95 per cent extraction of the ether was usual, with a standard deviation of 1.5 per cent. Thus, the overall accuracy was 3.9 per cent at the 99 per cent confidence limit. Because the extraction ratio tended to increase slowly with time, to 96 or 97 per cent if the samples were left in contact with the solvent overnight, separate reference standards were made for each sample and extracted in the same manner as the unknown samples. Overall accuracy was enhanced in this manner, since extraction time for both samples and standards was the same.

Increased Physiologic Shunting During Anesthesia and Surgery. H. H. BENDIXEN, M.D., J. HEDLEY-WHYTE, M.D., and M. B. LAVER, M.D., *Anesthesia Laboratory, Harvard Medical School, Massachusetts General Hospital, Boston, Massachusetts.* This study proposed to determine whether falls in arterial oxygen tension occur during clinical anesthesia, simultaneously with falls in pulmonary compliance; and to determine also if such falls in oxygen tension are reversible by sustained hyperinflation of the lungs. In the absence of periodic deep breaths, pulmonary compliance is known to decrease progressively (Mead, J.: Physiol. Rev. *41:* 281, 1961), caused, at least in part, by collapse of air spaces (atelectasis). The fall in compliance is reversible by sustained hyperinflation. If the perfusion of collapsed air spaces should continue, venous admixture to arterial blood, or increased physiologic shunting, would lead to a fall in arterial oxygen tension. If such a fall in oxygen tension is caused by collapse of air spaces, it should be reversible by sustained hyperinflation of the lung. *Method:* Fourteen surgical

patients, with no known pulmonary disease, have been studied. Pentobarbital and atropine were given as premedication, anesthesia was induced with thiopental, and succinylcholine was used to facilitate intubation. Anesthesia was maintained with halothane 1 per cent in oxygen, or with nitrous oxide and oxygen in ratios of 3 : 1 or 2 : 1. All patients received *d*-tubocurarine for profound relaxation. Ventilation was by mechanical respirators, always at a frequency of 20 to 25 per minute.

Total compliance was measured by the Super Syringe (Janney, C. D.: ANESTHESIOLOGY *20:* 709, 1959), *p*H by glass electrode, and tension of carbon dioxide and of oxygen by our modifications of the Severinghaus and the Clark electrodes. Amplification and recording was by a Sanborn no. 350–3600 system. Thorough inflation of the lungs was carried out just before the period of study, which lasted an average of 83 minutes. Following the initial inflation, arterial blood samples were drawn and compliance measured. During the study period the patient's position was unchanged and ventilation was with constant volumes and pressures, and was adequate (X arterial *p*H 7.48 units, $\bar{X}$ arterial tension of carbon dioxide 36.9 mm. of mercury). A progressive fall in total compliance ($\bar{X}$ 12 per cent) and in arterial oxygen tension (X 22 per cent) was demonstrated during the period of constant ventilation. *Results:* At the end of the study period successive passive hyperinflations were administered, and before and after each inflation arterial blood samples were drawn and total compliance measured. The first (20 cm. of water pressure sustained for 10 seconds) caused a 17 per cent rise in compliance and a 13 per cent rise in oxygen tension. With subsequent hyperinflations (30 cm. of water for 15 seconds; and 40 cm. of water for 15 seconds), there was no further increase in compliance, but mean oxygen tension rose 27 per cent and 41 per cent in relation to the value before inflations. The arterial oxygen tension was consistently lowest at the end of the period of constant ventilation; highest following hyperinflation. In nine patients breathing halothane 1 per cent in oxygen the lowest oxygen tension was $\bar{X}$ 312 mm. of mercury; the highest, after hyperinflation, was $\bar{X}$ 482 mm. of mercury. This difference was significant ($P < 0.01$). *Discussion:* The reported findings suggest that increased physiologic shunting may occur during anesthesia, but is reversible, at least in part. The magnitude of the gradients between inspired and arterial oxygen tension suggests that a mixture of nitrous oxide and oxygen, in a ratio of 3 : 1 (or higher), may cause hypoxemia. This assumption is supported by values found in our cases breathing this mixture. Following a period of constant ventilation, the arterial oxygen tension was $\bar{X}$ 75.6 mm., and after hyperinflation $\bar{X}$ 102.3 mm. of mercury. Comparing the effect of hyperinflation on compliance and on arterial oxygen tension, leads to the suggestion that an increase in compliance, following inflation, may in great part reflect changes in surface tension of already open alveoli, and re-opening of airspaces cannot be assumed to occur in parallel with an increasing compliance.

Effect of Hemorrhage on Rate of Fall of Plasma Thiopental Concentration. NORMAN A. BERGMAN, M.D., *Division of Anesthesiology, University of Utah College of Medicine, and Veterans Administration Hospital, Salt Lake City, Utah.* Diminished peripheral blood flow following hemorrhage has been postulated as the cause of the delay in redistribution of thiopental resulting in prolonged high levels of the drug in the central blood pool and in rapidly perfused vital tissues. This report describes attempts to verify this prediction experimentally by comparing the rate of disappearance of thiopental from plasma during normovolemia and following hemorrhage in dogs. *Method:* Endotracheal intubation and cannulation of femoral artery and vena cava via femoral vein were performed on dogs anesthetized with diethyl ether or halothane. Six control dogs were permitted to awaken without further manipulation. Four dogs had 25–30 ml./kg. blood withdrawn before being permitted to awaken. Four other dogs were subjected to identical initial hemorrhagic episodes but were maintained at a predetermined hypotensive level throughout the experiment by repeated withdrawals of blood. Upon recovery from inhalation anesthesia each animal received thiopental, 25 mg./kg. over a two-minute period. Mechanical assistance was