

ing solutions of ether in water or blood which were accurate to 0.1 mg. per cent. Weighed ampuls containing ether sealed in an atmosphere of nitrogen were placed in a mechanical device for applying a crushing force. This was enclosed in a flask containing a measured quantity of blood or water, and all air was ejected from the system by introducing mercury prior to breaking the ampul. Constant pressure and volume were maintained, and thorough mixing and removal of samples were permitted under anaerobic conditions. Analyses in the range of 25 to 150 mg. per cent have been carried out on 0.5 ml. samples with a reproducibility of ± 5 per cent and a standard deviation of 1.46 per cent. Work is being continued to reduce certain systematic errors, and an analytical method of even greater reproducibility is anticipated.

Differences in Effects of Cyclopropane, Ether and Halothane on Some Components of Anesthesia. THOMAS B. DAVIS, M.D., CLIFFORD L. MITCHELL, M.D., HUGH H. KEASLING, M.D., AND WILLIAM K. HAMILTON, M.D. *Division of Anesthesiology, Department of Surgery, and Department of Pharmacology, College of Medicine, State University of Iowa, Iowa City.* The progression of alterations in function in an organism exposed to increasing concentrations of pharmacological agents classed "anesthetics" has given rise to such phrases as "lightly anesthetized," "deeply anesthetized," and "depth of anesthesia." These terms imply that the effects of anesthetics as administered are constants and thus fail to convey accurately and completely information regarding the status of an organism. This study was based on the old concept that the anesthetic state is a composite depression of many functions and that the relative degree of depression of these functions depends on many factors. This report demonstrates the variations in alterations of functions which occur following administration of cyclopropane, ether or halothane. These experiments were carried out in 30 adult mongrel dogs. Following the intravenous administration of 20–25 mg./kg. of thiopental, a tube was tied into the trachea. The electrocardiogram, electroencephalogram, venous pressure, arterial pressure, and end-expired carbon dioxide were monitored con-

tinuously. Frequent records were obtained of respiratory volume. The effects of central stimulation of the ipsilateral sciatic nerve on the tone of the quadriceps muscle was determined at intervals. The animal was prepared for recording, allowed to recover until purposeful movements were observed and then ether or halothane was administered utilizing a non-rebreathing system or cyclopropane was administered via closed circle with carbon dioxide adsorber. Initial attempts to obtain cross-over data on more than one agent per dog were unsuccessful since even with two-hour intervals residual effects of the previous agent were noted. The data reported are based on single administrations in the last 13 dogs. In each experiment the inspired concentration of agent was sufficient to produce apnea in approximately twenty minutes. Under the conditions of these experiments heart rate, venous pressure, end expired carbon dioxide, respiratory rate and tidal volume progressed in a similar manner for all agents. The electrocardiogram was similar for all agents with the exception of ventricular arrhythmias late in the administration of cyclopropane to 2 dogs. Halothane consistently produced a marked hypotension in contrast to relatively little change following ether or cyclopropane. The arterial pressure pulses in halothane treated animals consistently exhibited a lowering of the incisura, widening of the pulse contour and a more gradual run-off. The pressure pulses were relatively unchanged following the other agents. Cyclopropane and ether induced progressive changes in the electroencephalogram, while halothane induced little change. Even at apnea, considerable low voltage, fast activity was present with the latter drug. All agents decreased the muscle response during the first six to eight minutes of administration. The response was not measurable after this time during ether or halothane administration; however, with cyclopropane the diminished response then remained unchanged throughout the remainder of the administration. These data support our working hypothesis that the anaesthetic state depends upon the agent utilized in its induction. Preliminary data indicate that rate of administration also alters the "pattern of depression." The present failure to note reported differences in ventilatory functions (probably

because of the afferent sciatic stimulation) indicates that many other factors must operate to influence the definition of "depth of anesthesia." It would seem that definition of the status of observable functions would facilitate the transfer of information presently lost by the use of terms such as "lightly or deeply anesthetized." [Supported by USPHS Grant B-1079.]

A Method of Indirect Blood Pressure Measurement During Cardiopulmonary Bypass. DOUGLAS W. EASTWOOD, M.D. *Department of Anesthesiology, University of Virginia Hospital, Charlottesville, Virginia.* To circumvent the difficulties of detecting blood pressure during cardiovascular bypass, a method utilizing a photoelectric cell has been developed and used satisfactorily during most of our "heart pump" operations. Each arterial pulsation fluctuation in the blood volume of the vessel network causes fluctuating changes in the density of the tissue. Using a sensitive photoelectric cell, a low voltage light bulb and a transistorized, battery powered amplifier, these fluctuations were picked up from any vascular mass of tissue through which the light could be transmitted. These amplified fluctuations were recorded on a graphic recorder, or used to produce an audible tone. The time constant of the system was adjusted so that only rapid fluctuations in density will be detected. A technical description of the instrument has been reported (*Anesthesiology* 20: 74, 1959). The photoelectric cell and light source were placed on opposite surfaces of the finger of an adult or the wrist of a baby and the light intensity and amplifier sensitivity adjusted to produce an intermittent tone or movement of the needle on the meter with each pulse. A pneumatic cuff was wrapped around the arm and inflated above the point at which the signal of the fluctuations disappear. The cuff is then slowly deflated. The point at which the signal again appears approximates the systolic pressure. During the use of a pump oxygenator for heart surgery a pulse may be felt and Korotkow sounds heard if the pulse pressure is high. This is especially true if the heart is beating and the aorta is not clamped. When the blood flow is dependent entirely on the "heart pump," the pump stroke

volume is small, the pulse pressure is small and not detectable by palpation or auscultation. The pulse monitor was capable of detecting the systolic pressure in these circumstances. During the past ten months cardiopulmonary bypass techniques were used in 57 cases in our hospital. The anesthesia was nitrous oxide to which was added one or more of the following: halothane, meperidine, succinylcholine, curare, and thiopental. In most of these cases the systolic arterial pressure was measured by this indirect technique. The patients ranged in age from 4 months to 51 years. The highest systolic pressure measured during use of the "heart pump" was 100 mm. Hg. Pressures were obtained by this method as low as 35 mm. Hg. When pressure fell below this point this method of pulse detection became unsatisfactory. Vasoconstriction was found to make the changes in tissue density too small to be detected, however a routine digital nerve block will remedy this situation. The validity of this technique was checked by direct arterial pressure measured by means of a Satham strain gauge and compared to the pressure recorded simultaneously by this indirect method. This method has been used also to measure systolic arterial blood pressures in infants and children, during hypothermia, and in obese patients.

Influence of Anesthetic Agents and Adjuvants Upon Intestinal Tone. JAMES E. ECKENHOFF, M.D., AND THOMAS H. CANNARD, M.D. *Department of Anesthesiology, University of Pennsylvania, School of Medicine, Philadelphia, Pennsylvania.* Measurements of intestinal tone were sought in 12 patients scheduled for abdominal operation whose intestinal tracts had been intubated with a Miller-Abbott tube. In the operating room, that portion of the tube leading to the balloon was connected to a strain gauge and intraluminal pressures were recorded on a Brush Recorder. Sufficient air to obtain an adequate recording was injected into the system to inflate the balloon. This was 30-60 ml., yielding a pressure of 5 to 15 mm. Hg. Control recordings were made for 10-30 minutes. Anesthesia was then induced and observations made of the influence of the various agents and adjuvants on bowel pressures. The posi-