

patients who undergoing surgery under various types of anesthesia, we collected similar data from 14 unanesthetized, unsedated subjects. *Methods:* After starting a slow intravenous infusion, blood pressure and pulse rate were recorded at two-minute intervals for one hour, thus establishing a steady state. When the dye was injected into the infusion tubing, most recipients were relaxed and drowsy. Systolic and diastolic pressure were obtained by auscultation of Korotkoff sounds and the pulse rate by palpation of a radial artery. After injection of 5 ml. of 0.8 per cent solution of indigo carmine, blood pressure and pulse rate were recorded every 30 seconds for ten minutes, and then every minute until they returned to previous levels. Similar determinations were made in three patients during cardiac catheterization, using arterial cannulas, an oscilloscope and a photographic recorder. Eight of the 14 subjects were anesthetized on the following day with similar measurements made by the indirect methods mentioned. *Results:* All systolic pressures of patients increased 4-50 mm. Hg and diastolic pressures rose 9-30 mm. Hg. Mean values were 17 mm. Hg and 19 mm. Hg, respectively. Pulse rate decreased by 8 to 20 beats per minute (mean 16 per minute) in all except one subject whose pulse was unchanged. Maximum alterations in pressures and pulse rate were attained within 1.5 to 3.0 minutes after injection. The duration of relative hypertension and bradycardia varied from two minutes to more than 30 minutes. There was no relationship between control values and increase in pressures or slowing of the pulse. All anesthetized patients developed hypertension and bradycardia. *Discussion:* These observations indicate that indigo carmine has a mild pressor effect. Whether the dye causes peripheral vasoconstriction or vasoconstriction plus a direct cardiac effect has not been ascertained. The bradycardia may be a reflex response from circulatory baroreceptors. The molecular structure of indigo carmine resembles two molecules of serotonin arranged as if one is a mirror image of the other. The similarity in structure to catecholamine compounds suggests a cardiovascular effect from its administration. The anesthesiologist who occasionally

administers this dye should exercise caution when administering it to hypertensive and cardiac patients.

Retinal Observations in Dying and Resuscitation. OSCAR FARMATI, M.D., STEPHAN KAMPSCHULTE, M.D., BULENT KIRIMLI, M.D., and PETER SAFAR, M.D., *Department of Anesthesiology, University of Pittsburgh School of Medicine, Pittsburgh, Penna.* Since the invention and introduction of the ophthalmoscope in clinical practice and research, the retina has been considered a mirror of intracranial events related to the cerebral blood circulation. Retinal and cerebral arteries have a common anatomic origin (i.e. internal carotid) and similar reactivity to Pa_{O_2} and Pa_{CO_2} changes in normal subjects. These vasomotor manifestations are concurrently and similarly altered also in atherosclerosis, diabetes, essential hypertension and glomerulosclerosis. Continuous retinoscopy and intermittent retinal photography were performed on lightly anesthetized, spontaneously breathing dogs which were subjected to rapid exsanguination, asphyxiation, and ventricular fibrillation. The observations were correlated with aortic pressure, Pa_{O_2} , Pa_{CO_2} , pH_a , hematocrit, ECC and EEG. *Exsanguination* (8 dogs): Rapid arterial hemorrhage resulted in zero arterial pressure in 2-12 minutes (blood loss 30-60 ml/kg), which was followed by apnea. No apparent changes of retinal circulation occurred until mean aortic pressure was approximately 50 mm Hg. Sludging of the blood started when aortic pressure was near 40 mm Hg, and fragmentation of blood columns was complete at 15 mm Hg aortic pressure. The EEG become isoelectric after the aortic pressure had dropped to 8 mm Hg or less. After five minutes of clinical death (apnea and pulselessness) resuscitation was started. Five dogs were resuscitated with rapid venous infusion of blood or blood substitutes with epinephrine and sodium bicarbonate; intermittent positive pressure ventilation with oxygen (IPPV/ O_2) and external cardiac compression (ECC). Three dogs had intra-arterial transfusion without ECC. The rate of retinal filling during resuscitation was equally rapid with blood as with substitutes; but more rapid with arterial

infusion without ECC than with venous infusion with ECC. During arterial infusion retinal filling started a few seconds prior to the resumption of spontaneous cardiac contractions. During venous infusion with ECC, segmentation persisted until adequate spontaneous cardiac action was restored. Color of vessels reflected hematocrit. *Asphyxia* (3 dogs): The tracheal tube was occluded until apnea and asystole were established. Sludging and fragmentation started at the same arterial blood pressure levels as during exsanguination. However, the EEG showed focal activity for more than 10 minutes after the onset of asystole. Retinal changes during resuscitation have been, so far, inconclusive. *Ventricular fibrillation* (3 dogs): Within about 5-10 seconds after cessation of circulation (aortic pressure zero) following electrically induced ventricular fibrillation, fragmentation of blood columns, perivascular edema, microhemorrhages, peripapillary exudations and disruptive changes of the vessels were seen in the deep (external) retinal layers. During and after successful restoration of circulation with IPPV/O₂/ECC and external electric countershock, only the fragmentation, but not the other retinal vascular and extravascular changes, were reversed. If these retinal observations reflect similar changes in the brain, they could be interpretive of clinical and experimental observations (Kampschulte, S., *et al.*, Fed. Proc. Abstr. 26/433, 1967) which suggest greater tolerance of the central nervous system to exsanguination cardiac arrest than normovolemic cardiac arrest. (Supported by U. S. Army Contract DA-49-193-MD-2160.)

Safety of Thiopental Used for Induction of General Anesthesia in Elective Cesarean Section. MIECZYSLAW FINSTER, M.D., and PAUL J. POPPERS, M.D., *Department of Anesthesiology, College of Physicians and Surgeons, Columbia University, New York, N. Y.* It is known that thiopental readily crosses the placenta and appears in significant concentrations in umbilical vein blood. However, our previous study (Finster, M., Mark, L. C., Morishima, H. O., Moya, F., James, L. S., and Dayton, P. C.: *Am. J. Obst. Gynec.* 95: 621, 1966) indicated that the drug administered during labor or delivery is usually pre-

vented from reaching the fetal brain in concentrations sufficient to cause depression even when the mother is anesthetized with as much as 400 mg. of thiopental. When the same dose is administered to mothers undergoing elective cesarean section, during which uterine contractions are absent and umbilical cord compression is infrequent, depression does occur in most of the infants. *Methods:* To determine the effect of the usual clinical dose of thiopental, healthy mothers scheduled for elective cesarean section were randomly assigned to receive either an intravenous injection of 250 mg. of thiopental or inhalation of 75 per cent nitrous oxide in oxygen, following a period of 3 to 5 minutes of denitrogenation. All patients were paralyzed with succinylcholine and intubated. Anesthesia was then maintained with a mixture of 70 per cent nitrous oxide in oxygen supplemented with a slow drip of succinylcholine 0.2 per cent. Ventilation was controlled manually. At birth, blood samples were taken from the umbilical artery and vein in a doubly-clamped segment of the cord and from the brachial artery of the mother. All samples were analyzed for pH, Pco₂, buffer base and base excess using the Astrup micro-method. All infants were evaluated by Apgar score at one minute of age. *Results:* Of 173 patients studied so far, 97 were induced with thiopental and 76 with nitrous oxide. The incidence of neonatal depression (Apgar score 6 or less) was higher with nitrous oxide (30.2 per cent) than with thiopental (24.7 per cent). Although the acid-base values of mothers were similar in both groups, fetuses in the nitrous oxide group were slightly more acidotic than those in the thiopental group. Mean values for umbilical artery pH were 7.24 and 7.26, respectively. The mean pH in the umbilical artery was lower in the depressed infants, particularly in the nitrous oxide group (7.20). *Discussion:* Duration of anesthesia prior to delivery appears to be the most important factor in the depression of the newborn. The mean duration of anesthesia was 22.7 minutes in the group scoring 6 or less versus 17.1 minutes in the 7-or-better group. The mean duration of anesthesia in patients induced with nitrous oxide was 21 minutes, whereas it was only 17 minutes in