indicative of cerebral hypoxia, and avoiding sudden and prolonged hypotension, the use of halothane in 100 per cent oxygen undoubtedly will enhance the safety of the technique.

SUMMARY

The effects of alteration of inspired oxygen concentration on jugular-bulb oxygen tension during deliberate hypotension induced by the combination of pentolinium, halothane and the head-up tilt position were studied in 15 patients. Increasing the oxygen concentration to 100 per cent by eliminating nitrous oxide consistently increased jugular-bulb oxygen tension. Possible mechanisms include increase in oxygen available to the brain and reduction of cerebral oxygen consumption. It is suggested that the administration of 100 per cent oxygen during induced hypotension may contribute to the safety of the technique.

REFERENCES


Intraoperative Doppler Blood Pressure Measurements in Infants

K. M. Janis, Capt, USAF, MC
William T. Kemmerer, Col, USAF, MC, F.A.C.S.
Robert R. Kirby, Maj, USAF, MC

Intraoperative and postoperative blood pressure monitoring in the neonate and small infant remains a problem. In a previous re-

* Department of Surgery, Anesthesiology Service, Wilford Hall USAF Medical Center, Lackland Air Force Base, Texas.
† Department of Surgery, General Surgery Service, Wilford Hall USAF Medical Center, Lackland Air Force Base, Texas.
Dr. Janis' present address: Department of Anesthesiology, University of Florida College of Medicine, Gainesville, Florida.
Send reprint requests to: William T. Kemmerer, Col, USAF, MC, CMR 8, Box 368012, Wilford Hall USAF Med. Center, Lackland AFB, Texas 78236.

port we described our experience with use of the Doppler ultrasound technique to monitor blood pressure in adults. Mention was made of the potential usefulness of this method for small infants. The method has been described.2-5, 4 This report describes the advantageous use of the Doppler technique to monitor blood pressure in eight infants less than 6 months of age who underwent surgical operations.

During evaluation of the use of the technique for small infants we have used the Parks Model 801 Doppler Ultrasound Flow
Detector,† which was modified by replacing the flow probe with a small flat transducer that may be placed under an infant blood-pressure cuff. Placement of the transducer beneath the cuff, as mentioned in the earlier reports, allows detection of the first arterial-wall-motion signal under the deflating cuff (systolic pressure) and the change of velocity of the wall-motion signal at the diastolic pressure level. In normotensive adult patients we had no difficulty in identifying distinct signals at systolic and diastolic levels.

We determined that in shocked adult patients the first signal heard from the transducer upon deflation of the overlying cuff represented flow rather than wall motion. Extensive use of the instrument in the small infant often has resulted in similar findings. In these instances, the flow signal was found to continue entirely throughout cuff deflation down to 0 torr, and diastolic pressure could not be obtained consistently. However, the systolic blood pressure has been found to be reliable and reproducible, a feat usually difficult or impossible in this group of patients by other nonpenetrating means. As is the case with most commercially available instruments, the Parks unit is tuned and filtered to detect blood flow and to ignore arterial wall motion. Under the occlusive cuff, however, it appears that the frequency shift in Doppler ultrasound generated by arterial wall motion is within the range of detection by the Parks unit under most circumstances. In contrast, other Doppler units in use in our laboratory normally ignore flow signals and are filtered to emphasize frequency shifts generated only by the arterial wall motion.

CASE REPORTS

Patients 1 and 2: A one-week-old 1.2-kg infant was suspected to be in shock during laparotomy for necrosis of the colon. Blood pressure was unobtainable by the Korotkoff method, but reproducible systolic and diastolic Doppler pressure values were obtained. Hypotension responded to the administration of whole blood. A second infant, 72 hours old and 1.4 kg in weight, underwent exploratory laparotomy with the same diagnosis. Once again, blood pressure was unobtainable with the Korotkoff method and clinical evaluation suggested presence of a shock state. Doppler pressures were within the normal range for the age and weight and there was no need for blood or fluid therapy to maintain a normal blood pressure throughout the procedure. Without the information provided by the Doppler unit, a distinction between shock and non-shock state with the need for appropriate fluid therapy could not have been made.

Patient 3: A 35-day-old 5.3 kg infant underwent excision of a meningocele. Immediately after induction of anesthesia with halothane and oxygen with the patient in the prone position, Korotkoff pressures became unobtainable; however, systolic pressures in the range of 35 to 40 torr were readily and reproducibly determined with the Doppler unit. After multiple attempts to raise the blood pressure by alterations in anesthetic technique and patient position it was decided that the infant was hypovolemic. Whole blood was given, with prompt response to pressure. Diastolic pressures were not obtainable in this infant.

Patient 4: A 13-day-old 3.2-kg infant underwent resection of a hepatoma under methoxyflurane anesthesia. At one point during the procedure, excessive blood loss suddenly occurred without producing very much alteration in venous pressure, pulse rate or electrocardiogram; however, the Doppler pressure fell from the preoperative level of 60/40 to 40/20 torr. Korotkoff pressures were unobtainable throughout the procedure. Rapid transfusion of warmed whole blood resulted in the rapid return of blood pressure to preoperative levels.

Patient 5: A 3-week-old 4.8-kg infant was operated upon for excision of a chest-wall mass. Immediately after induction by anesthesia with halothane, nitrous oxide and oxygen, the blood pressure fell suddenly to 30 torr systolic. Korotkoff pressures were unobtainable. Discontinuation of the administration of halothane was followed by a gradual elevation of the blood pressure to 90 torr systolic.

Patient 6: A three-week-old 3-kg infant in congestive heart failure was operated upon for closure of a patent ductus arteriosus. At one point in the procedure bradycardia occurred suddenly and the Doppler pressure became unobtainable. Korotkoff pressures were not obtainable at any time. Inspection of the heart revealed very feeble contractions. Blood volume was considered to be normal. The blood pressure rose to 140 torr systolic after the administration of inotropic agents. The infant survived the procedure without further difficulty.

Patient 7: A 3-month-old 3.1-kg infant with tracheomalacia and DiGeorge's syndrome underwent thymic transplant under local anesthesia. Although Korotkoff pressures were rarely obtainable, the pressure was maintained at 100 to 120 torr as detected by the Doppler unit throughout the procedure.

Patient 8: A 4-month-old 3.5-kg infant in congestive heart failure with suspected pulmonary agenesis was bronchosced without anesthesia. Attempts to obtain blood pressure by other non-

† Parks Electronics, Beaverton, Oregon.
invasive techniques were unsuccessful, but the Doppler method measured blood pressures consistently in the range of 90 to 100 torr systolic throughout the procedure.

This representative group of infants illustrates the manner in which Doppler blood pressures may be of value. On several occasions, blood pressure information vital to safe anesthetic and surgical management was obtained when it was impossible to achieve these measurements by other noninvasive techniques. On occasions not mentioned in this report, when Korotkoff determinations were available, there was close correlation with the Doppler measurements. In a recent review of pediatric anesthesiology, Rackow and Salanitre concluded by noting: "We still lack a simple, reliable way of measuring blood pressure in the small infant." With the instrumentation presently available, we feel that we may now determine blood pressure in infants under conditions in which it is unobtainable by other noninvasive methods.

REFERENCES


Self-administration of Intravenous Analgesics

WILLIAM H. FORREST, JR., M.D.,* PETER W. R. SMETHURST, M.B.,
CH.B., (FFARCS),† MARTIN E. KIENITZ, M.A.†

An instrument that safely administers analgesic drugs intravenously when a patient feels the need and can be activated by his pressing a button or similar device may have clinical and research application, particularly in the management and investigation of postoperative pain. Small doses of analgesia given intravenously can provide rapid, safe pain relief. The intravenous approach may avoid some of the disadvantages and hazards which are present when larger doses are given by other parenteral routes. A patient-activated system would ensure instantaneous analgesic medication at times of peak pain intensity.

Patient-activated systems, in which a series of gas-driven electronically-controlled pistons inject into the patient's infusion line a fixed volume of analgesic solution, have been described by other workers. A new apparatus (Demand Dropmaster), which automatically dispenses intravenous analgesic drugs on demand has been developed for use at the Veterans Administration Hospital, Palo Alto, as a part of the VA Cooperative Analgesic Study. Built by Corbin Farnsworth and designed in conjunction with one of the authors (WHF), the system uses a gravity-feed principle whereby drug-containing solutions may be fed into a maintenance infusion line. The device is composed of two interconnected units. The master unit, stationed outside the room, controls and monitors infusion rates and drug doses. The small bedside unit further regulates intravenous fluid flow. The design concept is fail-safe.

An infusion stand supports a maintenance infusion bottle (M.I.B.) and the analgesic infusion bottle (A.L.B.). The tubing from the M.I.B. passes through a solenoid valve on the bedside unit (fig. 1). The tubing from the A.L.B. passes through its appropriately num-