a man may be cold and somewhat cyanosed, with a weak pulse, yet the blood pressure be within normal limits. This patient's need is a cardiac tonic such as nikethamide plus oxygen. On the other hand, the pulse may feel average but the blood pressure is below 80 mm. Hg; here a pressor agent is required. Observers who have taken thousands of pressure readings constantly report such findings, and also their inability to estimate the blood pressure by palpating the pulse.

A male, 24 hours after a three-quarter partial gastrectomy for a large gastric ulcer and a duodenal ulcer, collapsed and became unconscious. His respirations were 48 and forcible, the pulse was 160, but the heart-beat was regular and sounded strong at the apex. The blood pressure was 80/60 (cardiac index 33%) and his nails were white. In this case oxygen and a pressor agent to restore the blood pressure were necessary. Both were given, and in five minutes consciousness was regained and recovery followed. The conventional cardiac tonic would probably have been ineffective.

Another finding is that of simultaneous cardiac and pressure weakness or failure. The pulse is feeble and irregular and the pressure low. A combination of nikethamide or leptazol 1 c.cm. and pholedrine 1 c.cm., given together intramuscularly, yields a powerful effect.

Fluid Loss.—Should there have been a considerable loss of fluid, as after gross injuries or extensive operation, then an infusion of blood or plasma is necessary to fill up the circulatory system. Stimulants or saline will not act in this capacity: in fact, continuous saline is harmful to shocked patients because the body has no storage facilities for salt-and-water, which waterlogs the bases of the lungs.

Post-operative Observations.—Post-operative observations of the blood pressure are important after the use of spinal anaesthetics and after the shock-producing procedures. Low readings are found up to four days after operation. Response to pholedrine or methedrine or intravenous hypertonic saline is prompt.

Summary

The Moot-McKesson cardiac index is described and its value indicated in major operations.

Some factors affecting the blood pressure at operations are described.

After operations, the need to give primary attention to the cardiovascular system rather than to the operation area is emphasized.

The help available from blood-pressure readings in the choice of the correct remedy is described.

Continuous intravenous infusions of saline post-operatively in shocked patients are deprecated.

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CONTINUOUS ADMINISTRATION OF INTRAVENOUS ANAESTHESIA

A SIMPLE METHOD

BY

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In view of the increasing popularity of intravenous anaesthesia and the growing number and complexity of devices (Semans, 1941) for its administration, we would like to place on record a method which we have been using at the Middlesex Hospital for more than two years. It is simple to carry out, gives accuracy of dosage, and is economical in materials.

The Apparatus

This is a positive-pressure drip saline infusion apparatus (Fig. 1), consisting of a saline reservoir, drip-bulb and tubing, glass aspiration indicator, needle, and a means of providing positive pressure.

1. **Pressure.**—This is provided as follows: (a) *By a hand bulb*—e.g., of a sphygmomanometer or Higginson's syringe. A clip is often needed to prevent leakage back through imperfect valves. (b) *By an oxygen cylinder.* A Y-tube is connected in the tubing

from the reducing-valve of an oxygen cylinder to the flowmeter. The remaining arm of the "Y" is joined to the shorter tube of the saline reservoir. By restricting the flow from, say, 4 litres a minute to 2 litres, by means of a screw-clip on the tubing which

FIG. 1

leads to the flowmeter, enough pressure is built up to drive over the saline (Fig. 2). The 2 litres a minute from the flowmeter can be administered to the patient via a nasal catheter, B.L.B. mask, or in combination with nitrous oxide from a Boyle machine.

FIG. 2

2. **Saline Reservoir and Rubber Stopper.**—(a) The Baxter vacoliter screw-topped saline-bottle has the advantage that it is squat and not easily overturned, and the screw top cannot be blown off. (b) Any bottle in which sterile saline for intravenous use is supplied can readily be adapted by fitting a suitable-sized rubber stopper with two holes through it. Two tubes—metal, to prevent breakage—are pushed through the rubber stopper. One of these reaches almost to the bottom of the container; the other ends above the surface of the saline.

3. **Drip-bulb.**—A Murphy or similar drip-bulb is attached to the longer of the two tubes by rubber tubing; a clip on this regulates the flow of saline.

4. **Rubber Tubing.**—The latex type of tubing is the most satisfactory, as air bubbles can be seen through it.

5. **Glass Connexion.**—Apart from joining the latex tubing to the pressure tubing, this will show if blood had diffused back along the tube when the needle was introduced into the vein. If the connexion remains free of blood, only that part of the apparatus distal to it need be sterilized or changed between cases.

6. **Pressure Tubing.**—This is used as it withstands repeated needle puncture without leaking. It should be about 4 to 6 in. in length.

7. **Aspiration Indicator.***—This is a short straight glass tube with a small bulb blown in its centre. There are two metal mounts—one to fit a needle, and the other to fit a Record syringe. The indicator can first be used between syringe and needle (Fig. 3) when

FIG. 3

the induction dose is given. The aspiration test of the position of the needle can be performed without contaminating the syringe with blood. The indicator is then removed and fitted between the pressure tubing and a larger needle.

8. **Needle.**—A short-bevel size 1 (Record) about 1½ in. long is quite large enough (equivalent to about 4 or 5 serum needle).

9. **Arm Splint.**—A piece of wood about 4 in. by 1½ in. by 4 ft. is padded for half its length. Two domette "tails" are attached to the padding to fix the arm in place.

10. **Tourniquet and adhesive tape** are also required.

Technique

Pressure is raised in the saline reservoir and the regulating clip opened, allowing saline to flow until all air bubbles are removed. The clip is closed, and the level in the drip-bulb is adjusted by the clip on the side tube. The patient is then induced, using up to 0.5 g. of 5% pentothal solution in a 10-c.cm. syringe. For ease of venepuncture and the patient's comfort use the aspiration indicator and a fine needle (Vann Bros. "evipan" size) (Fig. 3). The

* Also known as "varicose vein amount"; obtainable from John Bell and Croyden Ltd.

patency of the airway is maintained by positioning of the patient's head or by the insertion of a soft rubber oral airway (Guedel type); or a short nasopharyngeal tube is passed through the nose. We have found it beneficial to employ supplementary nitrous-oxide-oxygen anaesthesia (see below).

The patient is now transferred to any desired position on the operating table, and one arm is firmly bound to a splint, the unpadded end of which is inserted beneath his shoulder. The tourniquet is applied and the needle inserted into a suitable vein. With the drip turned off, the venous congestion produced by the tourniquet causes blood to diffuse back into the indicator—proof of the intravenous position of the needle. The drip is now started (40 to 50 drops a minute), and the needle is fixed in position by adhesive tape. We have found that the needle is held more securely and lateral movement prevented if a small piece (1 in. by $1\frac{1}{2}$ in.) of tape is placed beneath the needle with the adhesive side uppermost. Two longer pieces are then applied over both needle and tape, securing them to the surrounding skin (Fig. 4).

FIG. 4

Further injections of 5% solution of pentothal are made, as required, by syringe and needle into the pressure tubing, which should be pinched on the drip-bulb side during the injection to prevent "backwash" and consequent delay in the passage of the drug to the patient.

Advantages

Positive-pressure drip apparatus eliminates the cumbersome unstable stand required by gravity drips, and as the saline reservoir can be placed quite near the vein, long lengths of tubing are avoided.

The glass aspiration indicator facilitates venepuncture.

Should the needle become dislodged between the injections of pentothal, saline only will be introduced into the subcutaneous tissues. In other methods (Rivett and Quayle, 1940; Macintosh and Pask, 1941) irritant pentothal may so escape.

Accurate doses of pentothal can easily be injected and their full effect quickly assessed. The same concentration of the drug (5%) is used throughout, thus avoiding error due to different solutions.

The absence of Y-tubes joining separate containers of saline and pentothal (Rivett and Quayle, 1940; Thomas, 1942), syringes, multi-directional taps (Rivett and Quayle, 1940; Semans, 1941), and numerous lengths of tubing lessens the weight attached to the arm and hence there is less likelihood of the needle becoming dislodged. More important is the lack of "dead space" (Adams, 1941) in the apparatus we describe; hence there is minimal delay in action of the drug due to "backwash" and uncontrollable dilution.

Supplementary Anaesthesia or Oxygen

Organe and Broad (1938) reported a series of cases in which supplementary nitrous-oxide-oxygen anaesthesia was used. Various other writers have advocated supplementary oxygen (Carraway, 1939; Carraway and Davison, 1941; Davison, 1943). In endorsement of these views we have found that supplementary nitrous-oxide-oxygen anaesthesia is of value because: (1) The total dosage of pentothal required is considerably smaller, hence the degree and duration of post-operative respiratory depression are reduced to a minimum. (2) A continuous visual indication of the patency of the airway and the volume of respiratory exchange is provided by the movements of the rebreathing-bag. (3) The percentage of oxygen can be increased greatly in excess of that found in atmospheric air, thus overcoming anoxia due to shallow respiration. (4) Rhythmic pressure on a rebreathing-bag filled with oxygen provides the most efficient form of artificial respiration should apnoea occur.

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A FATAL CASE OF CEREBRAL MALARIA

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Cerebral malaria is a rare cause of coma in this country, but with the return of large bodies of our troops from areas where subtertian malaria is endemic this complication may be seen more frequently. It is a medical emergency which often responds well to early treatment, but its gravity can be judged by the mortality of 40% recorded by Sandford, Crawford, and Warr (1940) in a series of 48 cases. The following description of a fatal case is presented as a reminder that malaria should be considered in the differential diagnosis of coma and that, unless treatment is started early, gross irreversible pathological changes occur in the brain.

Case History

On Sept. 2, 1942, a 28-year-old stoker was admitted to a naval hospital in a semi-comatose state, having been sent from a destroyer whose previous travels were not divulged. He had been suffering from a severe headache for three days, but had not reported this as he had not wanted to miss going on leave. On the morning of admission he had reported sick, complaining of a severe headache, frequent vomiting, and fever. No abnormal physical signs had been found by the medical officer of the destroyer. The patient had lapsed into a semi-comatose state during his journey from the ship to hospital.

On examination he was found to be semi-comatose, but was easily roused by a loud voice or a pin-prick; he was not able to speak, and was incontinent of urine. T. 103, P. 120, R. 28. The skin was dry and muddy-coloured but burning hot. The teeth were tightly clenched. The pupils were contracted and slightly irregular, and reacted sluggishly to light; the fundi showed no abnormality. There was no paralysis of the limbs, and the muscle tone was normal. The deep reflexes were all present, but were sluggish. Abdominal reflexes were present. Plantar responses were flexor. There was no neck rigidity or positive Kernig's sign. A few moist sounds were heard at the base of the right lung. Heart sounds were normal. B.P. 110/70. The abdomen showed no rigidity and the liver and spleen were not palpable.

In view of the possibility that he might have a meningococcal septicaemia he was given 1 g. of sulphapyridine intramuscularly while the following investigations were being carried out:

Urine: Specific gravity 1014, acid; a heavy cloud of albumin, blood-positive chemically, numerous red blood corpuscles and granular casts seen. *Blood:* Urea, 42.1 mg. per 100 c.cm.; sugar, 85 mg. per 100 c.cm.; leucocyte count, 14,200 per c.mm. (polymorphonuclears 77%, lymphocytes 12%, large mononuclears 11%). *C.S.F.:* Lumbar puncture revealed clear fluid under normal pressure, containing 3 cells per c.mm., no excess of globulin, 50 mg. of protein and 92.8 mg. of sugar per 100 c.cm.

In view of the negative findings it was thought that the diagnosis lay between septicaemia and cerebral malaria. Blood films were therefore taken; numerous ring forms of *Plasmodium falciparum* were found, but no crescents. An intravenous 5% glucose-saline drip was started immediately. 10 gr. of quinine dihydrochloride together with 10 min. of 1/1000 adrenaline hydrochloride was dissolved in 20 c.cm. of water and given slowly by a hypodermic syringe into the rubber tubing of the drip apparatus. The intravenous glucose-saline was continued throughout the night, and on the morning of Sept. 3 the patient was fully conscious and able to recognize his relatives. His general condition seemed much improved (T. 99.2°, P. 100), but persistent vomiting prevented the administration of fluids by mouth. A further dose of 10 gr. of quinine dihydrochloride was given in the same manner as before. His condition continued to improve during the day. A blood count showed 4,400,000 red cells per c.mm.; haemoglobin 100% (Haldane); and 18,000 leucocytes per c.mm. On Sept. 4 his temperature rose to 104°; his appearance was more icteric, and he again lapsed into coma. Lumbar puncture was repeated and 10 c.cm. of clear fluid was removed. 10 gr. of quinine was given intravenously and a slow-drip blood transfusion was started. No improvement resulted from these measures, and by the morning of Sept. 5 his condition had greatly deteriorated. The blood urea was 118 mg. per 100 c.cm. His temperature had risen to 105°, and despite frequent tepid sponging it remained between 104° and 105° until death occurred on Sept. 6.

At necropsy the salient features were as follows. Brain: Congestion of the vessels on the surface of the cerebral hemispheres; numerous petechial haemorrhages present throughout the brain, but more so in the cerebral hemispheres than in the brain-stem. Spleen: Enlarged to twice normal size, dark, soft, and flabby; pulp purplish