vitamin therapy that was tried. This remission was followed by a decline, which ended in death. Marked hyperplasia of the bone marrow was found. This description corresponds very well with the cases in our series, and in spite of the fact that parenteral liver was not used the case might very probably have been one of achrestic anaemia.

Of the cases described by Davidson² two (Nos. 5 and 8) might have been of the type under discussion. Both had a megalocytic anaemia with free hydrochloric acid in the gastric juice; both showed resistance to anti-anaemic therapy; and both showed remission and relapse. Post-mortem details were not available. De Crespigny,¹ in reporting some cases of rare anaemias, describes one as "anaemia of aplastic type" which presents features similar to the cases of this series. There was a severe megalocytic anaemia with free hydrochloric acid in the gastric juice, and reticulocytes varying from 9.5 to 17 per cent. It is not really clear that the case was resistant to liver, and no post-mortem details are given.

Thompson, Richter, and Edsall,⁸ in a valuable paper calling attention to the miscellaneous conditions that have been labelled aplastic anaemia, describe a series of cases among which one (No. 2) showed a severe anaemia that refused to yield to all forms of anti-anaemic treatment. At the post-mortem examination hyperplasia of the marrow was found. Details available, however, are not sufficient to make sure of the diagnosis.

Of these seven reports from the literature only the case described by Kennedy presents any really adequate evidence for a retrospective diagnosis of achrestic anaemia; the others are suggestive in varying degree.

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J. S. Anderson (*Arch. Dis. Child.*, December, 1934) illustrates the mild character of scarlet fever at the present time by the fact that of 1,743 cases admitted to the Leeds City Hospital in 1933 only one showed the malignant type, while twenty-three were examples of the septic type. The relapse rates for this hospital during the years 1931, 1932, and 1933 were 3.6, 4, and 4.3 per cent. respectively. Anderson attributes this relatively high relapse rate to the present benign type of scarlet fever providing insufficient stimulus for the development of immunity. Since October, 1933, he has Dick-tested every patient who is not given scarlatinal antitoxin on admission, and in the case of positive reaction gives a course of graduated skin doses of toxin (500, 2,000, 5,000, and 20,000 skin doses at four-day intervals). The injections were well tolerated, and did not have the slightest adverse effect upon the disease. The result was that of 246 patients who were given toxin only one had a relapse.

SOME EXPERIENCES WITH SPINAL ANAESTHESIA

BY

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The following remarks apply to some 500 cases in which spinal anaesthesia was used for all kinds of operations in lesions below the diaphragm—mostly in the upper abdomen and chiefly on the gall-bladder and bile ducts. In order to keep the conditions as uniform as possible I have used the same anaesthetic and given all the injections myself. The anaesthetic employed was durocaine light solution (specific gravity 1002). It was put up in phials of 3 c.cm., each cubic centimetre containing planocaine 0.1 gram, gliadin 0.00325 gram, in 15 per cent. ethyl alcohol. Recently the supply ran out and could not be replenished; however, Messrs. May and Baker were able to make a substitute (M & B 116) of the same specific gravity, which seems to act practically as durocaine.

Technique

Whether any one reagent has a decided advantage over any other I do not know, but I am sure it is wise to become as fully acquainted as possible with one and develop a uniform technique with it. In this way a confidence is acquired which otherwise would be uncertain.

The procedure adopted in practically all my adult patients has been as follows. Nembutal, 4½ grains, is given by the mouth three and a half hours before operation, and a further 3 grains half an hour before operation, with morphine 1/4 grain, atropine 1/100 grain, and ephedrine 3/4 grain. Other basal anaesthetics have been tried, but discarded in favour of the above. On arrival in the theatre the patient is nearly always asleep, but stirs when pricked, though there is no memory of this. With the patient on his left side and the back fully flexed a drop or two of novocain is injected into the skin in the middle line of the space between the third and fourth lumbar vertebrae, and a spinal needle of the Barker type is inserted here into the theca. A little fluid is run off, 2 c.cm. collected into the syringe which already contains the 3 c.cm. of anaesthetic solution, and then returned moderately quickly into the theca. The rate at which the injection is made is kept as constant as possible. If the pressure of the cerebro-spinal fluid seems higher than usual rather more is run off before injecting. The speed of injection is, I feel sure, one of the factors concerned in the distance to which the anaesthetic reaches, and it is very important, therefore, that this part of the technique should be performed by the same person each time.

Immediately the injection has been made the patient is turned on his back and the table raised to bring him into an upright sitting posture, in which he is kept until there is no response to pinching of the skin with a sharp-toothed forceps just below the umbilical level. At this stage the patient is promptly lowered into a moderate Trendelenburg position, the degree being such that shoulder supports are just necessary to prevent him sliding towards the head end of the table. It usually takes about three minutes, or just under, for anaesthesia to reach the level indicated, and a few minutes later it is found that the upper limit has risen to half-way between the nipple and the clavicles.

Controlled Height of Anaesthesia

During this stage of the procedure two points are clearly established. First, if bleeding occurs through the spinal needle and persists so that blood-stained fluid is drawn into the syringe, there is no certainty as to the efficacy

of the anaesthetic. Secondly, the height of anaesthesia can be quite definitely controlled by the position of the patient—for example, when a lower limb is to be amputated or a prostate removed, the patient is not placed in a sitting position at all, and the anaesthesia of the skin does not rise above the level of the umbilicus. This is important from the practical point of view, and seems to me to point clearly to the method by which the anaesthetic is disseminated in the thecal cavity when other factors are kept constant. Variations in speed and quantity of injection alter the level of anaesthesia, but I think there is better control by keeping these factors constant while varying the time of the patient's position.

Marked muscular relaxation is a well-known feature of spinal anaesthesia, and materially facilitates access to deep-seated parts in fat patients. There is also a complete absence of any tendency of the abdominal viscera to thrust into the wound, and in those cases in which the organs need to be packed out of the way the ease with which this can be done and maintained is remarkable. Moreover, omentum can be placed at the end of the operation just where it is wanted, and the absence of intestinal excursions allows it to remain in position.

FIG. 1.—Case of duodenal ulcer. Operation: posterior gastro-enterostomy; appendicectomy. X = Spinal injection. A = Peritoneum opened. B = Gastro-enterostomy begun. C = Ephedrine 3/4 grain. D = Appendix removed. E = CO₂ and O₂ begun. F = Operation finished. Forty minutes.

After-effects

I have had no deaths under spinal anaesthesia. In a few cases there has been a complaint of headache; this appears to come on when the patient is propped up in bed, and can be relieved quickly by the recumbent attitude; I have only once seen this headache sufficiently severe really to worry the patient. I have had one case of strabismus; this lasted three days and then completely vanished. There have been no other ill consequences of spinal anaesthesia in my cases. Post-operative chest complications are no more frequent than after ether; in fact, the general post-operative course is smooth, and usually unaccompanied by vomiting or flatulence. When the anaesthetic effects begin to pass off they continue to do so rather rapidly, and I think the patients often require morphine earlier than when ether is used, for wound pain. There seems to be no doubt that many patients with acute conditions, especially those with acute obstructions, have a much easier post-operative course than those who have had ether anaesthesia, due to less disturbance of the factors concerned in acid-base balance of the blood.

With so many apparent advantages held by spinal anaesthesia, why is it not more widely used? There is only one reason which has any real weight with me, and that is the fall in blood pressure which is so constantly associated with high anaesthesia.

Fall in Blood Pressure in High Anaesthesia

It is part of the routine procedure to take systolic blood pressure tracings throughout the operation. With anaesthesia extending to just short of the clavicles the usual occurrence is a fall in pressure beginning about five minutes after the spinal injection, and reaching its maximum descent in ten to fifteen minutes. This coincides with the abdominal incision and the opening of the peritoneal cavity, and the graphs give the impression that the fall has something to do with these manipulations; but I think the fall is mainly coincidence, since the same thing occurs at the beginning of any operation in which anaesthesia reaches a high level, even when the abdomen is not opened. I am quite sure it is the height to which the anaesthetic rises which accounts for the fall in blood pressure. The average fall is about 40 mm. of Hg—that is to say, an initial blood pressure of 120 in fifteen minutes drops to around 80, and thereafter fluctuates near this level, usually rising in forty-five minutes to approximately the original figure. It is at this time that the anaesthesia induced by durocaine is rapidly passing off. (Figs. 1 and 2.)

FIG. 2.—Case of gall-stones. Operation: cholecystectomy; choledochotomy; appendicectomy. A = Abdominal incision. B = Peritoneum opened. C = Appendix removed. D = Gall-bladder removed. E = Common duct opened. F = Tube inserted. G = CO₂ and O₂ begun. H = operation finished. Fifty minutes.

Cause of the Fall in Blood Pressure

The principal factors in maintaining blood pressure are: force and rapidity of the heart beat, peripheral resistance, blood volume, and the suction action promoted by chest excursions on venous return. Under high spinal anaesthesia the heart beat is slow and not forcible; it is slowed because the accelerators are put out of action, since they leave the cord for the most part below the second dorsal segment; the tonic action of the vagal nerves remains.

The peripheral resistance is lowered because the vasoconstrictors are paralysed in the anaesthetized area; ephedrine is given before operation with a view to contracting the arterioles by direct action. I am not sure how far it is of use; I am inclined to think that with the patient in the Trendelenburg position it is not necessary. Although I have no definite proof that the anaesthetized limbs increase in size from the relaxed condition of the vessels, it is probably fair to assume they behave in the same way as the penis, which can be seen quite clearly to be distended and relaxed.

It is unlikely that vasomotor paralysis of the lower limbs has much to do with the fall in blood pressure, since there is no fall when anaesthesia is limited to the umbilical level. When anaesthesia reaches the second dorsal segment the splanchnics are put out of action, and, according to physiological evidence, division of both

splanchnics is followed immediately by a marked fall in pressure, which is attributed to accumulation of blood in the relaxed abdominal vessels. I think this is true to some extent in the human being, though it is difficult to prove. The veins in the various mesenteries seem to me to be rather fuller under spinal anaesthesia than when ether is used, but this is not a very marked feature so far as any one vessel is concerned. Possibly, also, the solid organs are distended; I have no evidence one way or the other as regards this, but it is difficult to believe that the intestines contain an excess of blood, since they are markedly contracted and diminished in calibre. From what I have observed in the abdomen at operation it seems reasonable to conclude that sufficient blood accumulates in the venous side to account for a fall, and probably the greater part of the fall, in pressure under spinal anaesthesia.

Concerning the third factor—blood volume—there cannot be any material deviation from the pre-anaesthetic content of the vascular system, for the following reasons. First, there is no evidence to suggest that fluid is accumulating in the tissues outside the vessels; secondly, the blood pressure can be so easily raised and lowered by a method to be described below that it is unreasonable to suppose there is any loss of blood volume (apart from the small loss of blood which attends any operation); and thirdly, those conditions are absent which can so readily lead to heavy loss of fluid—namely, sweating and deep breathing. To these it is probably right to add that the diminished calibre of the intestines and the absence of any tendency on the part of the latter to prolapse into the wound materially lessens loss of fluid by evaporation. Under ether fluid loss from these sources may be very great, and one of the real assets of spinal anaesthesia is its conservation of fluid within the body.

The fourth factor in the maintenance of blood pressure is the venopressor mechanism described by Henderson.¹ He was concerned mainly with the action of carbon dioxide on this mechanism in the post-operative period. Beecher,² as the result of an experimental study, denies the value of carbon dioxide therapy in preventing the crippling of the respiratory system after laparotomy. Clinically, my experience coincides with Henderson's conclusions, which ascribe the beneficial effects of carbon dioxide primarily to its action on blood pressure, and, secondly, to its action on the lungs. Whatever the post-operative results may be there is no doubt at all about the effect of carbon dioxide during operation under spinal anaesthesia. I have many graphs illustrating this, of which Fig. 3 is typical. The mixture is 10 per cent. carbon dioxide in oxygen, and it is given through a mask in much the same way as gas and oxygen. After a few breaths there is a very obvious deepening of the respirations without any quickening of the rate and a prompt rise of many millimetres in blood pressure; the pulse rate remains as before. When the carbon dioxide inhalation is stopped blood pressure tends to relapse almost at once. The sequence of events is so

clearly connected with the depth of breathing that the explanation would appear to be the better filling of the heart, induced by the suction exerted on the venous blood.

No doubt other factors are concerned, and probably an important one is the following, which was suggested to me by W. A. Bain of the physiological department in the Leeds Medical School. Accumulation of venous blood in the splanchnic area implies an asphyxial effect on the adrenals, which are thereby excited to active secretion of adrenaline; this is poured into the adrenal veins. Under the influence of carbon dioxide inhalation the venous blood is sucked into the heart, and a relatively large dose of adrenaline is suddenly passed into circulation. The beneficial effect of carbon dioxide administration is so obvious that I now use it during the early minutes of operation, and I have succeeded, so far as I can judge at present, in limiting materially the initial fall in blood pressure.

The fall in blood pressure, therefore, seems to be due to a widening of the vascular system in the greater part of the body, together with some degree of holding up of the blood in the mesenteric veins particularly. Breathing carbon dioxide in oxygen can rectify and, to some extent, prevent the fall, presumably because of the deep inspiration induced, a suction action being set up which gives the heart more blood to pump forward. The Trendelenberg position assists the blood in its return to the heart. There are some who say it is unnecessary to worry about the fall in pressure, and experience suggests there is some truth in this. However, it seems advisable, with

the means at hand, to maintain the pressure as near the original level as possible.

A Curious Occurrence in Spinal Anaesthesia

A curious state of affairs occurs occasionally for which I find difficulty in supplying a satisfactory explanation. Anaesthesia may be so extensive that the patient is apparently unable to appreciate the sensation of a prick or nipping with sharp-toothed forceps as high as the scalp; the corneal reflex disappears, and yet breathing continues as before. This may happen when the patient has had no previous medication with nembutal; moreover, though conscious at the beginning of the operation, the patient falls asleep at this stage of extensive anaesthesia.

There seem to be two possible explanations. First, the anaesthetic is absorbed into the blood and so distributed all over the body; however, the same dose is used as for a low anaesthesia, when absorption must occur, and yet it is never followed by the phenomena just described, and animal intravenous experiments seem to discount this theory. Secondly, dissemination occurs along the spinal canal into the skull in an attenuated form. It is known that cocaine and its derivatives act more readily on the sensory nerve fibres than on the coarser motor fibres, and perhaps novocain and its derivatives act in the same way; it is possible this is the reason the phrenics escape. One would expect the blood pressure to fall very low if the

FIG. 3.—Case of carcinoma of sigmoid involving small intestine. Operation: enterectomy, lateral anastomosis; colectomy, Paul's method. A = Abdominal incision. B = Peritoneum opened. C, F, I, and M = CO₂ on. D, G, J, and N = CO₂ off. E = Enterectomy. H = Enterostomy. K = Colectomy (mobilization). L = Inguinal incision. O = Operation finished. Eighty minutes.

anaesthetic reached the medullary level and beyond, and in most of the cases I have seen this has happened. In one of my cases, however, the pressure did not fall below 85 mm. Hg, and that is not an unduly low pressure in any case of high spinal anaesthesia. Whatever the ultimate reason may be, I believe it is initiated by maintaining the erect sitting position too long. I think this was undoubtedly why the patients in two of my earliest cases developed respiratory paralysis: both recovered after keeping up artificial respiration for about twenty minutes, with intravenous gum saline in one, but the experience was a very unpleasant one. I have had no similar cases since.

Animal experiments show that novocain derivatives, such as are used for spinal anaesthesia, can, when applied directly to the floor of the fourth ventricle, produce respiratory failure; so can a very low blood pressure, indirectly, by causing anaemia of the bulb centres. I doubt whether, in the human being, the anaesthetic ever reaches the medulla in sufficient concentration to cause primary respiratory stoppage. On the other hand, if no means are taken to check the fall in blood pressure it can drop to between 50 and 60 mm. Hg without cessation of breathing, but so low a pressure must be getting very near the level at which an effective circulation cannot be maintained. The lowest pressure recorded in my series was 42 mm. Breathing became very shallow, but did not cease; prompt administration of carbon dioxide and intravenous gum saline quickly carried the pressure to over 80 mm., and it did not fall again below 60 mm. This occurred during excision of the rectum by Kraske's method.

In practice I regard a pressure of 80 mm. as an indication for carbon dioxide, and now I seldom see a pressure as low as 65 mm. If there was not a prompt reply to carbon dioxide I should at once infuse gum saline, or saline alone, if the other were not handy.

Effect of Spinal Anaesthesia on Smooth Muscle

Temporary paralysis of the vaso-constrictors of the somatic areas is well known as a result of spinal anaesthesia, but relaxation of smooth muscle generally is not one of its characteristics. This is clearly seen in the abdomen. Immediately the peritoneal cavity is opened, and before any manipulation of the intra-abdominal viscera is begun, the contracted state of the small intestine and the activity of its peristaltic movements are striking events. The calibre of the intestine is reduced to that of an ordinary lead pencil, and at intervals of two or three inches strong contractions of the circular muscle appear to obliterate the lumen entirely. The large intestine cannot be seen easily without some manipulation, but it can be felt to be strongly contracted, and gives the impression that one is handling a thick-walled rubber tube. Strong segmental contractions occur here also, and this state of affairs is noticeable as far down as the sigmoid. Curiously enough the stomach, which is the most muscular part of the intestinal tract, does not show anything like the same degree of activity; nevertheless, contractions can be seen, especially on handling the organ. The bladder does not appear to be contracted, nor does it alter its contour when handled. Since it receives its parasympathetic supply from the lower end of the cord, one would not, of course, expect it to show any activity under spinal anaesthesia.

These observations seem to fit in with the physiological data, which point to general inhibition occurring (with few exceptions) in the splanchnic area as a result of sympathetic stimulation. The removal of this inhibitory mechanism under spinal anaesthesia allows the unaffected

vagi free scope for their motor display. That the vagi are concerned in this hyperactive state of the intestine is, I think, quite clearly shown by two further observations I have made at operation. First, when the abdomen is opened under local anaesthesia considerable activity of the intestine is seen, but it is not nearly so marked as when a spinal anaesthetic has been given. Secondly, drawing down the stomach strongly, pulling on the caecum, and manipulating the gall-bladder and bile ducts under spinal anaesthesia produced a feeling of oppression and nausea which was often promptly followed by vomiting. It was thought that this was probably due to vagal impulses, and might be prevented by blocking the vagi. Consequently a fair quantity of 1 per cent. novocain was injected all round the oesophagus at its junction with the stomach. Vomiting was prevented in patients so treated as soon as the abdomen was opened, also the intestines ceased almost at once to be contracted and no longer writhed about, except locally when touched with the fingers. Sometimes there was a fall of a few millimetres in the blood pressure, but whether this was a part of the fall which is usually observed at this period of the operation, or whether it was due to a further widening of the splanchnic vascular bed, could not be decided.

There is a good deal to learn about spinal anaesthesia, and I think from it, if we observe carefully. It almost never fails, except in the occasional case when blood is drawn into the syringe, and with the technique I have described I feel confident of its safety. I still use ether quite often, and frequently have comparable cases performed under the two anaesthetics. Generally speaking, the patients receiving spinal anaesthesia are more comfortable next day and suffer distinctly less from flatulence. I am sure this is so if one compares the more difficult cases, and especially those of not too good a risk; in these one does not see the flushed face, hyperpnoea, dehydration, and dyspnoea which occur after ether, and indicate acid-base changes. Without wishing to appear to decry the value of ether or to extol unduly that of spinal anaesthesia, I think we are rather apt to overlook the post-operative morbidity which may reasonably be attributed to ether, since it is definitely a tissue poison and especially damaging to kidney function. Rather a severe criticism of it is made in a recent publication by Bhatia and Burn.³

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A report has been issued of the seventh annual conference on health education, which was held in London last November under the auspices of the Central Council for Health Education. It contains abstracts of the speech by Sir George Newman in which he indicated the lines of advance necessary for further education; the review by Dr. James Fenton of the development of the public health system in this country; and the contributions made by Professor J. A. Nixon and Dr. W. G. Savage to the discussion on the education of the public in regard to nutrition, in the course of which reference was made to the Somerset scheme for the teaching of cookery and marketing to girls in schools. Briefer notes are also supplied of the second discussion on the education of the public in respect of the consumption of milk. Copies of the report may be obtained from the offices of the Central Council, 1, Upper Montague Street, Russell Square, W.C.1.