At the age of 42 he was re-examined. The blood pressure was 208/126. The retinal vessels showed no change from their previous state. Radiologically the heart was still slightly larger, the transverse diameter being 15.5 cm.

Three months later he was seized with the symptoms of myocardial infarction, from which he died very suddenly.

He had clearly suffered from prolonged severe hypertension. This remained harmless to his health or his life for 25 years, the absence of complications during that time being due to the excellent state of his arteries. The adequate supply to his heart muscle enabled the left ventricle to remain healthy and to support the hypertensive burden without in any way failing. Atheroma, however, supervened towards the end, and a fatal coronary thrombosis caused his death. The increasing heart size over the last few years was ominous, although symptoms were absent until the end.

He was a sensible and helpful patient, and it was a tragedy that his disease terminated shortly before the introduction of effective hypotensive drugs. Sympathectomy was thought of, but its failure in so many similar cases led to its not being tried, especially in a symptomless patient.

Hypertension, Unchanged for 11 Years

Mrs. K. was first seen at the age of 65 for attacks of giddiness. She had incidentally a raised blood pressure. The detailed history of her symptoms suggested that the attacks of giddiness were vestibular in origin, the function of the middle ear being affected by local arteriosclerosis. On examination the heart rate was 90 and the blood pressure 230/126. The heart was normal clinically and radiologically. The orthodiagram gave a normal transverse diameter of 11.5 cm. The electrocardiogram showed upright T waves in the left ventricular leads and no evidence of left ventricular hypertrophy.

She was seen eleven years later, when she was 76 years old. Her attacks had continued. Her description of the attacks was now not so clear, and it was difficult to disentangle the possible causes as between vestibular disturbance, vasovagal faintness, and functional or psychogenic influence. On examination she again had a nervous tachycardia of 90; the blood pressure was 220/120. The heart remained clinically normal. Radiologically there was some increase in size, the transverse diameter being 13.7 cm. The electrocardiogram was that of a normal horizontal heart. The unipolar limb leads and the unipolar precordial leads V1 to V6 were all used.

She clearly was a woman in whom there was a static, so-called benign, hypertension. Since the heart becomes more bulky in normal people in the 70's and 80's the increase in the transverse diameter is not so significant as it would have been in a younger individual. The hypertension as such was clearly harmless, and her case was a good example of the fact that the prognosis in elderly women with a raised blood pressure is so frequently extremely good.

Conclusions

It is not claimed that this record of long-term cases can provide any accurate statistical guide to the prognosis in the various conditions mentioned. The purpose is to offer proof that a prolonged period of good health may be expected in individual patients. From this it follows that the clinician must carefully analyse all his cases, as individuals, from the point of view of the state of the heart muscle at the time of examination, the changes of deterioration or improvement in the state of the heart muscle, the absence or the presence of mechanical handicaps which might interfere with cardiac efficiency, and the removability of these by medical or surgical means. He should also, so far as the facts will allow him, emphasize to his patients the possibilities of a good prognosis so that their co-operation in a positive constructive line of life may be obtained. It is only by

so doing that those individuals in whom a good prognosis is possible will be enabled to achieve it to its maximum extent.

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BLOOD TRANSFUSION IN OBSTETRIC HAEMORRHAGE WITH REFERENCE TO VALUE OF ESTIMATIONS OF BLOOD VOLUME

BY

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This paper is concerned with the position of blood transfusion and the value of blood-volume estimations in obstetric shock, mainly in cases of concealed accidental haemorrhage. Grant and Reeve (1951) and Crosby and Howard (1954) have shown that estimations of blood volume are of considerable value in the treatment of shock due to blood loss in battle casualties. This work is being followed up on civilian casualties in the Birmingham Accident Hospital by Clarke, Topley, and Flear (1955) and Clarke and Flear (1956). In view of this, one of us (A. D. T.) estimated the blood volume in a number of cases of obstetric haemorrhage as a guide to the amount of blood to administer. In the treatment of obstetric shock the problem of when and in what quantity to administer blood can be a difficult one. This is especially true of concealed accidental haemorrhage, and there is diversity of opinion regarding the best methods of local and general treatment. Clarke and Fisher (1956) state clearly the difficulties arising from the provision of pint bottles of blood. A bottle of blood contains 100 to 120 ml. of anticoagulant, and in fact we transfuse approximately 400 ml. of the whole blood in a bottle. This explains our stating the amounts of blood transfused in millilitres; thus a transfusion of five bottles approximates to 2 litres of whole blood.

By "severe accidental haemorrhage" we mean cases where the patient is admitted with concealed and/or revealed accidental haemorrhage and in whom the foetal heart cannot be heard. Crichton (1950), in an analysis of 120 cases in Capetown, gave a maternal mortality of 10.9%. Sheehan and Moore (1952) described 700 cases of severe accidental haemorrhage with 75 maternal deaths—a mortality of 10.7%—and their criterion of severity was a dead child *in utero*.

Our views on local treatment in accidental haemorrhage are based on those of the late Professor Marshall Allan (1940), of Melbourne, who taught that artificial rupture of the membranes was advisable. Professor Allan followed this treatment with pituitary extract, but we do not use intramuscular pituitary extract or oxytocin because of the possible association of afibrinogenaemia with excessive uterine action. We are coming more and more to the view that caesarean section has little to offer in this condition except in the mild case associated with

foetal distress. Townsend (1955) states: "At the Royal Women's Hospital, Melbourne, we have adopted a very conservative method of treating accidental haemorrhage. We consider that there is no maternal indication for caesarean section in accidental haemorrhage." He does not mention the use of oxytocin. Some of our cases were complicated by afibrinogenaemia, and if present this was treated with intravenous fibrinogen or concentrated plasma. The whole problem of the place of blood transfusion is emphasized by the following tragic case.

A gravida-1 aged 22 was admitted at 40 weeks with severe revealed and concealed accidental haemorrhage. The blood pressure was 135/80 and the pulse rate 110, and the urine contained albumin. The uterus was tense and tender and the foetal heart was not heard. Low rupture of the membranes was performed, and over the next 20 hours the blood pressure varied between 110/80 and 165/115, but the pulse rate rose and stayed at 150 to 160. During this time 800 ml. of blood and 1,200 ml. of dextrose saline were given. Forceps delivery of a stillborn male infant weighing 3,746 g. was followed by general collapse of the patient and a post-partum haemorrhage of 2,400 ml. of fresh blood and 900 ml. of old clot. No further vaginal blood loss occurred. The pulse rate remained elevated to 160 and the blood pressure fell progressively over the following 12 hours despite transfusion of 1,600 ml. of blood. At the end of this time the patient was pale, sweating, restless, and anxious. Sudden collapse and death occurred.

Clinical assessment of this case on admission gave a false impression of the state of the patient's circulating blood volume, and we are now of the opinion that it would have been much safer if the patient had been transfused more actively. She might then have been fit to withstand the post-partum haemorrhage.

Subsequently, a case of traumatic post-partum haemorrhage was treated successfully by the administration of 13,600 ml. of blood (Lennon and Tovey, 1956), and one of us (MacGregor, 1955) reported two cases of severe accidental haemorrhage transfused with 9,600 ml. and 10,400 ml. of blood respectively. Both these patients had excessive post-partum haemorrhages but no circulatory collapse; the urinary output following delivery was satisfactory.

Haematological Methods

On admission, apart from the clinical assessment of the case, blood samples were taken and the following tests performed:

Haemoglobin.—This was estimated on a heparin sample, using an M.R.C. grey wedge photometer.

Packed Cell Volume.—Duplicate tests were performed, using Wintrobe 10 by 0.25 cm. haematocrit tubes, and the blood was centrifuged at 3,000 r.p.m. for 30 minutes in a standard M.S.E. centrifuge.

Plasma Fibrinogen.—Two methods were used: (1) A "bedside" method which was performed in order to give a quick rough guide to the presence of a fibrinogen deficiency before the result of the longer quantitative method was available. Thus treatment, if required, could be administered quickly. The "fibrindex" method as recommended by Scott (1955) was employed. (2) The micro-Kjeldahl method as described by Harrison (1947).

Blood Group.—If not already known, the patient's blood group was determined and a number of bottles of blood were cross-matched.

Estimation of Blood Volume.—As most of the patients are shocked and need active treatment very quickly, a method must be used which is simple and rapid, and causes as little disturbance to them as possible, thus allowing the treatment to be unhampered by the investigations and in-

vestigators. The direct method, using the dye Evans blue (T.1824) as described by Mollison (1951), was therefore employed, as it proved to be the most satisfactory one for routine use. Occasionally, when a repeat estimation several hours later was required, red cells tagged with ⁵¹Cr were used. It was realized that, especially in obstetric patients, the direct method employing the dye does give a rather larger error than a red-cell-tagging method (Verel, Bury, and Hope, 1956). This is due to the fact that the body/venous haematocrit ratio appears to vary in these cases. In view of this variation no ratio was used. In most cases the changes in blood volume were very large and so the error was minimized. After obtaining a "blank" venous sample with minimal stasis 20 ml. of dye (approximately 15 mg. of the dye in 20 ml. of isotonic saline) was injected through the same needle and a sample taken from another vein after 10–15 minutes' interval. In the early stages samples were taken at 10 and 20 minutes, but as both gave almost identical results only one sample was taken in subsequent cases. The dye concentration was measured in an EEL photometer with 620 m μ filter, and 3-ml. volumes of plasma were used, the anticoagulant being heparin. No sample was haemolysed and no gross lipaemia was found. In one case the plasma was faintly lipaemic, but the standard gave readings identical with the ones obtained in other cases where the plasma was clear. The standard consisted of 0.02 ml. of the dye added by means of an "agla" micrometer syringe to 3 ml. of plasma from the "blank" sample.

In a number of cases admitted to the Obstetric Unit blood-volume estimations were made in order to assess blood requirements. The following six cases are reported.

Case 1

A gravida-1 aged 22 was admitted to hospital at 34 weeks with a diagnosis of concealed and revealed accidental haemorrhage. The patient was moderately shocked, and on abdominal examination the uterus was hard and "woody"; no foetal heart was heard. Her pulse rate was 84 and her blood pressure 130/80. Blood examination revealed a haemoglobin level of 10.4 g. per 100 ml. (70%) and a packed cell volume of 28%. The bedside fibrinogen test gave no firm clot in 30 seconds, and the laboratory test gave a result of 190 mg. of fibrinogen per 100 ml.

The blood volume was found to be 3,300 ml. (47 ml./kg. of body weight), consisting of a plasma volume of 2,500 ml. (36 ml./kg.) and a red-cell volume of 800 ml. (11 ml./kg.). We attempted in all cases to restore the patient's blood volume to 80–90 ml./kg. of body weight, and on this basis calculated that the patient required 2 litres of blood, which was given in two hours. The membranes were ruptured and the patient went into labour. However, in spite of this transfusion, the pulse rate rose to 120, the blood pressure remaining at 120/90. A further 1,200 ml. of blood and 1,200 ml. of plasma was given in the next four hours and the pulse rate fell to 108, the blood pressure remaining unchanged.

Eight hours after admission the patient was delivered, by forceps, of a fresh stillborn female infant. The total estimated loss was 2,100 ml., which included a post-partum haemorrhage of 1,200 ml. A further 400 ml. of blood was given, making a total of 3,600 ml. of blood and 1,200 ml. of plasma. Subsequently the patient progressed well; her post-partum urinary output was adequate. The haemoglobin level on the fourth day was 14.8 g. per 100 ml. (100%).

Comment.—In spite of a normal pulse rate and blood pressure on admission the patient was deficient of about 2 litres of blood. She withstood the post-partum loss well because she had been adequately transfused.

Case 2

A gravida-4 aged 31 was admitted at 31 weeks with a diagnosis of concealed and revealed accidental haemorrhage. She was not shocked, the pulse rate being 70 and the blood

pressure 135/85. The uterus was tense and tender, foetal parts were not palpable and the foetal heart was not heard. The urine contained albumin. The haemoglobin level was 12.4 g. per 100 ml. (84%) and the packed cell volume 34%. Blood taken had not clotted after 10 minutes and when it finally occurred clot retraction was poor.

The blood volume was 3,800 ml. (66 ml./kg.), consisting of a plasma volume of 2,500 ml. (44 ml./kg.) and a red-cell volume of 1,300 ml. (22 ml./kg.). It was estimated that 1,200 ml. of blood was required, and this was given.

Low rupture of the membranes was performed and five hours later she was delivered of a stillborn infant weighing 1,700 g. A post-partum haemorrhage of 600 ml. occurred.

The patient gave no cause for alarm and her convalescence was uneventful. The post-partum urinary output was satisfactory and on no day was the volume less than a litre.

Comment.—This was another case where the blood pressure and pulse rate did not suggest a depleted circulating blood volume (Gibberd, 1948).

Case 3

A gravida-1 aged 18 was admitted at 36 weeks following a mild ante-partum haemorrhage. Clinically she was not shocked, her pulse rate was 92, and blood pressure 150/110. The urine contained albumin, the uterus was enlarged to 36 weeks, foetal parts were palpable, and the foetal heart was heard. The haemoglobin was 14.4 g. per 100 ml. (97%) and the packed cell volume 40%.

The blood volume was found to be 5,100 ml., which was within the normal range for the patient's weight. Labour began four hours after admission, and four hours later a live female infant weighing 4 lb. 8 oz. (2,040 g.) was born; after 11 hours it died of atelectasis and tentorial tears. There was a post-partum haemorrhage of 500 ml., and 800 ml. of blood was transfused. The puerperium was uneventful.

Comment.—In this case estimation of the blood volume confirmed the clinical impression that there was no deficiency of circulating blood volume.

Case 4

A gravida-3 aged 33 was first admitted at 29 weeks following a mild ante-partum haemorrhage, and a provisional diagnosis of placenta praevia was made. She remained in hospital until the 37th week, when the bleeding recommenced. Lower segment caesarean section revealed a central placenta praevia. The blood loss at operation (estimated to be about 3,000 ml.) was excessive and 2,000 ml. of blood was transfused rapidly but the blood pressure did not rise above 90/? and the pulse rate was 124. The patient was restless and shocked. The blood volume was 3,100 ml. (48.5 ml./kg.); the plasma volume 2,100 ml. (33 ml./kg.), and the red-cell volume 1,000 ml. (15.5 ml./kg.). It was estimated from her weight that there was a blood-volume deficiency of 2 litres. In view of this a further 2,000 ml. of blood was administered—800 ml. quickly and the remainder over eight hours. The blood pressure rose to 120/80 and the pulse rate fell to 70.

She progressed uneventfully and her haemoglobin was 14.7 g. per 100 ml. (99%) on the fourth post-partum day. Urinary output following the delivery was satisfactory.

Comment.—The clinical impression that the blood volume had not been sufficiently restored was confirmed by estimation of the blood volume. Although after the transfusion of 2,800 ml. of blood her pulse and blood pressure were within normal limits, she still required a further 1,200 ml.

Case 5

A gravida-7 aged 32 was admitted at 22 weeks with an intrauterine foetal death. The uterus was enlarged only to the size of a 14-weeks cyesis, and she was losing blood per vaginam.

Evacuation of the uterus was performed because of the persistent loss, and, although after this the uterus contracted well, the blood loss continued. Intrauterine packing did not control the loss, and hysterectomy was performed. By the end of the operation 2,000 ml. of whole blood had been given. The bedside fibrinogen test showed a severe depletion. In view of this, 800 ml. of triple-strength plasma was given with a fibrinogen content of approximately 6 g. This was followed by 6 g. of fibrinogen. Blood transfusion was continued, and 22 hours after operation the patient had received 8,800 ml. of blood and 800 ml. of triple-strength plasma. The blood loss had ceased and the fibrinogen test revealed a normal clotting-time. At this stage the blood pressure was 80/50 and the pulse rate 110. The blood volume was calculated to be 2,600 ml. A further 3,200 ml. of blood was given and the pulse rate fell to 90. The patient progressed well for 16 days and her haemoglobin on the fourth post-partum day was 13.6 g. per 100 ml. (92%). On the 16th day a brisk vaginal haemorrhage occurred, necessitating the transfusion of a further 1,200 ml. of blood. Subsequently her convalescence was uneventful. Altogether she had received 13,200 ml. of blood and 800 ml. of concentrated plasma. Although it appeared that the blood loss had been replaced by massive blood transfusion, the clinical impression of a markedly depleted blood volume was confirmed by laboratory estimation.

Comment.—Barry, Geoghegan, and Shea (1955) believe that afibrinogenaemia rarely develops within eight weeks of intrauterine death, and this case agrees with their findings.

Case 6

A gravida-3 aged 34 was admitted at 30 weeks with a diagnosis of concealed and revealed accidental haemorrhage. She was pale and shocked; the pulse rate was 104, the blood pressure 170/100, and the urine contained albumin. The uterus was enlarged to 36 weeks and was tense and tender. The foetal heart was not heard and blood-stained liquor drained per vaginam. She was given 600 ml. of plasma and 300 ml. of blood. The blood volume was found to be 3,900 ml. (71 ml./kg.), consisting of a plasma volume of 3,100 ml. (56 ml./kg.) and a red-cell volume of 800 ml. (15 ml./kg.). The haemoglobin level was 6.7 g. per 100 ml. (45%). She was regarded as a case of toxæmic accidental haemorrhage superimposed on a chronic anaemia.

The membranes were ruptured and 1,600 ml. of blood was given over a period of eight hours, the haemoglobin level being raised to 10.5 g. per 100 ml. (71%). Because of her long-standing anaemia before admission the plasma volume was not depleted to the same extent as her red-cell mass. In view of this it was decided not to transfuse her any further with whole blood but to use concentrated red cells, and 400 ml. was given. Eighteen hours after induction she was delivered of a live premature infant weighing 2 lb. 6 oz. (1,080 g.), and this was followed by a post-partum haemorrhage of 700 ml. The patient's general condition had improved, the blood pressure being 200/130 and the pulse rate 72. There was no evidence of venous congestion. However, the blood pressure continued to rise and two hours after delivery it was 210/140. Bromethol, 4 ml., was administered per rectum. Five hours after delivery the blood pressure was 200/120. During the next three days it ranged between 200/115 and 225/120, and ominously the urinary output was scanty, being 90 ml. on the first, 120 ml. on the second, and 400 ml. on the third post-partum day. On the fifth day she became distressed and cyanosed, the blood pressure remaining at 225/120. Digoxin, 0.5 mg., and aminophylline, 0.25 g., were given intravenously and a venesection was performed. She did not improve, and died on the seventh post-partum day.

Post-mortem Findings.—Each pleural cavity contained about 300 ml. of yellow fluid, and the lungs had considerable areas of pulmonary oedema. The heart showed slight hypertrophy of the left ventricle. The left kidney

weighed 210 g. and was swollen and pale. The right kidney weighed only 110 g. and showed severe chronic pyelonephritis.

Comment.—Until the patient developed hypertensive cardiac failure on the fifth day of the puerperium there had been no pulmonary congestion or distension of the neck veins to suggest circulatory overloading. If too much blood had been given at the time of delivery she would have developed circulatory failure within 48 hours. In fact, her general condition improved over this period. Bull, Joekes, and Lowe (1955) emphasized that in the case of patients who are pre-eclamptic the prognosis in accidental haemorrhage is more serious, and we suggest that underlying renal disease is prejudicial to the outcome.

Discussion

Grant and Reeve (1951) demonstrated clearly that in some instances a patient could have a circulating blood volume of 70% of normal with no clinical evidence in the form of variations in pulse rate and blood pressure. This appears to be the case in obstetric haemorrhage, and explains Gibberd's (1948) observation that in accidental haemorrhage the initial pulse rate may be slow having regard to the poor general appearance of the patient. If in a shocked patient blood is administered to restore blood pressure and pulse rate to normal, the circulating blood volume may still be greatly depleted, and if a further haemorrhage occurs the outcome may be fatal. A further interesting point is that the blood "lost" may not be completely accounted for. Crosby and Howard (1954) were unable to account for the total blood loss in their cases of severe battle injuries, and this has been shown to be true in obstetric cases (Verel *et al.*, 1956). We have confirmed this observation, as, after careful estimation of the blood loss and replacement of this amount, the patient may be left with a depleted circulating blood volume as in Case 1. It is difficult to believe that the difference between the estimated loss and the true state of the circulation can be due to blood loss into uterine muscle.

In our experience assessment of the amount to be replaced needs to be guided wherever possible not only by the measured blood loss but also by measurements of blood volumes. The transfusion of large volumes of blood guided by estimations of blood volume has not produced any untoward complications. In no case did the patient develop signs of overloading of the circulation. Even when 12,000 ml. of blood was given in a few hours, as in Case 5, the patient not only showed no sign of venous congestion but continued to improve.

Many patients admitted with accidental haemorrhage are initially hypertensive, and the blood pressure on admission is often of very little help and may even be extremely misleading. The disease may be complicated by severe anaemia (Case 6). If estimation of the blood volume reveals a considerable depletion in the presence of an apparently normal or slightly raised blood pressure, the only criteria of response to treatment are a falling pulse rate and the general demeanour of the patient.

If the pulse rate continues to rise, the patient is in need of further transfusion. Our aim in these cases has been to bring the pulse rate down to the region of 100. We have found that where no facilities are available for estimating the blood volume the following scheme of management is of value. If a patient has been seemingly adequately transfused, but clinically the general condition, pulse rate, and possibly the blood pressure are unsatisfactory, an examination is made of the neck veins and the lung bases. If there is no evidence of circulatory overloading 800 ml. of blood is given within 10 minutes, a careful note being made of the blood pressure and pulse rate. A falling pulse rate indicates a previously depleted circulating blood volume, and transfusion should be continued until the pulse rate approaches 100. This therapeutic test has been found to be safe so long as a careful watch is kept for circulatory overloading. In practice we have found that in the large majority of cases where the patient has not responded to an

apparently adequate amount of blood she has been suffering from under-transfusion, and we believe the dangers of over-transfusion have been unduly emphasized. This is in agreement with the views of Clarke and Fisher (1956) in cases of civilian trauma. The ultimate fate of the patient and her pituitary and renal function will be seriously jeopardized if prompt and adequate treatment of the shock due to blood loss is not combated.

Grant and Reeve (1951) say, "The first thing the clinician should learn is that there is hardly one sign of shock which is constant." An important observation is the general demeanour of the patient. The patient who is restless, anxious, pale, and sweating as the result of blood loss may not require sedation with morphine. We believe that intravenous morphine in the severely shocked anaemic patient may well prove fatal, and we have demonstrated in one case that with adequate blood transfusion controlled by estimation of the blood volume the patient with the above symptoms will soon be safely asleep without sedation, even in severe accidental haemorrhage.

Two of the maternal deaths in O'Donel Browne's series (1952) had caesarean section performed, and he commented that early blood transfusion had been neglected.

Where adequate treatment was administered the urinary output remained satisfactory, and the patients had a diuresis in the immediate post-partum period. This latter effect was interpreted as being due to the prevention of prolonged renal anoxia. In Case 6 the urinary output was unsatisfactory, but necropsy revealed underlying renal disease without any evidence of renal cortical necrosis.

Crichton (1950) states: "The ultimate prognosis after accidental haemorrhage is not good. Stroink (1934) found that 51% of patients had developed arteriosclerosis, nephritis, or apoplexy in a follow-up extending from two to twenty years. de Snoo (1936) conducted a similar analysis and found 61% to be hypertensive."

Summary

Estimations of the blood volume are of considerable help in the treatment of severe obstetric haemorrhage and are a guide to the amount of blood to be administered.

In some instances patients may have a circulating blood volume of 70% of normal with no clinical evidence in the form of variations in pulse rate and blood pressure. The blood loss may not be completely accounted for (Case 1).

In severe accidental haemorrhage the blood pressure on admission may mislead because many patients are initially hypertensive. The disease may be complicated by anaemia.

The patient suffering from severe obstetric haemorrhage should have the haemoglobin, packed cell volume, plasma fibrinogen, blood group, and blood volume determined on admission.

When blood is transfused in adequate amounts the immediate complication of renal cortical necrosis is averted because renal anoxia is of short duration and the remote prognosis may be improved. The cases described illustrate this and the value of studies of the blood volume.

The aim of transfusion should be to enable the patient to withstand the subsequent effect of haemorrhage and trauma, and we have attempted to restore the patient's blood volume to 80–90 ml./kg. of body weight.

There is a tendency to under-transfuse cases of obstetric haemorrhage. This can be avoided by estimating the blood volume, and a clinical test is described should facilities for this not be available.

It is emphasized that a bottle of blood contains 400 ml., not a "pint," of blood.

There is no maternal indication for caesarean section in severe accidental haemorrhage.

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"ENDOGRAFIN" AS A MEDIUM FOR HYSTEOSALPINGOGRAPHY

BY

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With the advent of intensive investigation of the problems of infertility, the following report is made of our experience with the use of "endografin" as a contrast medium in hysterosalpingography.

The continued interest shown in the use of new media for this radiographic examination suggests that no entirely satisfactory substance has yet been evolved, although it is over 45 years since Rindfleisch (1910) first visualized the outline of the uterine cavity with bismuth paste. The pioneer work of Cary (1914) and of Rubin (1915), who independently introduced collargol, was followed by the use of different solutions containing halogen salts and later by the development of iodized oil, of which "lipiodol" is the best-known representative. Iodized oil was applied to gynaecological problems by Heuser (1925, 1926) and remained almost the sole agent employed for many years. The disadvantages of iodized oil are too well known to warrant detailed repetition. They include the danger of embolic phenomena and of extensive foreign-body reactions within the tubes and in the peritoneal cavity.

Later, the organic iodine-containing compounds were prepared and adopted for salpingography, either in their

original form or in some modified form. The desirable properties expected of these media may be briefly summarized as: (1) the material injected should have no undue likelihood of irritating existing inflammatory conditions and should be absorbed within a few hours, leaving no trace behind in the tubes or in the peritoneal cavity; (2) it should be dense enough to cast a clear shadow; (3) it should be sufficiently viscous so that the outline of the tubal lumen can be accurately visualized to demonstrate strictures or other abnormalities; (4) its consistency should allow it to pass through the uterus and Fallopian tubes slowly enough to be filmed accurately; (5) its consistency should be such that a reasonably watertight seal is obtained in the cervix without resorting to an unnecessarily traumatic cannula; and (6) the agent should give rise to a minimum of pain and discomfort to the patient.

It is generally agreed that aqueous solutions do not generally fulfil these criteria satisfactorily, as their viscosity is too low. Such solutions, however, have the advantage of being relatively non-irritating, but, as with more viscid media, spasm may prevent even watery solutions from demonstrating patency.

In order to increase the viscosity of contrast media several substances have been combined with the organic iodine compounds. Titus *et al.* (1937) investigated dextrose, starch, glycerin, propylene glycol, tragacanth, and acacia combined with methiodal sodium ("skiodan"). The optimum solution was considered to be 40% methiodal sodium in 20% acacia, and this substance has been widely used. Similarly, "rayopaque," which included polyvinyl alcohol, and, more recently, media combined with dextran, carboxymethylcellulose, and polyvinylpyrrolidone (P.V.P.) (widely used as a plasma extender) have been employed. None has been entirely satisfactory. Solutions containing P.V.P. have excellent handling characteristics, have given rise to little pain, and have been technically suitable. Solutions of P.V.P. have been extensively used as plasma extenders, and the excretion of P.V.P. has been extensively studied. Altemeier *et al.* (1954) said that up to 49% of 1,000 ml. of a 3.5% solution of P.V.P. was retained in the body for at least 20 months. It has been suggested that some of this material is retained in the reticulo-endothelial system. Campbell *et al.* (1954) claim that 65–90% of P.V.P. is excreted by the kidneys within 48 hours of the injection. One can safely say that it is not clear what percentage of P.V.P. is retained and what are the consequences, if any, of this retention, though there is no proof of any untoward effect and so far there is certainly no confirmation of the unpublished report of possible carcinogenic action in experimental animals.

Endografin is an aqueous solution of the methyl glucamine of N:N-adipic-(α -amino-2:4:6: -triiodobenzoic acid). It contains no supplements to increase its viscosity, the latter being determined by the molecular size and the concentration (70% as compared with "biligrafin forte" 50%). Viscosity measurements at body temperature are endografin 18 centipoises, biligrafin forte 6 centipoises. Biligrafin forte has been used extensively in the investigation of the biliary tract, the incidence of serious reactions in this application having been notably low.

Technique

The technique used by us involved the insertion of a Currie cannula without preliminary analgesia, except in two apprehensive patients who received intravenous pethi-