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ORIGINAL MEMOIRS.

TRANSFUSION BY CARREL'S END-TO-END SUTURE METHOD.

WITH REPORT OF CASES.

BY EUGENE H. POOL, M.D.,

AND

R. D. McCLURE, M.D.,

OF NEW YORK.

THE interest in direct transfusion of blood, aroused in the last few years chiefly by the work of Crile, has centred upon efforts to develop an easy and reliable method of forming the anastomosis. All of the numerous methods which have been advocated are really modifications of one of four procedures, namely: end-to-end suture—Carrel; approximation by apparatus—Crile, Elsberg, Soresi, Levin; vessel interlocking by end or lateral implantation—Hartwell; interposition of a foreign body link—Brewer, Frank.

A detailed discussion of these cannot be given here. Time and experience alone can prove which of the methods is the best. Careful reports of efforts at transfusion should be encouraged, so that sufficient wealth of material may accumulate to lead to definite conclusions.

Series of cases in which the various methods have been

employed are most instructive, and it is for this reason that we report twelve transfusions which have been made by the Carrel method of end-to-end suture. The therapeutic indications for transfusion likewise present a fertile field for physiological and surgical research, but we do not feel that our experience has been sufficient to warrant elaborate discussion of this phase of the subject.

The technic as initiated by Carrel is as follows: A donor free from advanced arteriosclerosis and giving no history or signs of syphilis is chosen. Hæmolytic and agglutination tests with the two bloods may be carried out if circumstances permit, but the necessity for and value of these tests are undecided.

A radial artery of the donor and a vein of the arm or leg of the recipient are the vessels of selection. One-half per cent. novocaine is used as the local anæsthetic. Adrenalin must not be combined with the novocaine on account of its constricting action on the vessels. In addition to the usual dissecting instruments, two small thumb forceps, several serrefine clamps of varying strength covered with rubber tubing to avoid injury to the vessel wall, fine Chinese silk, No. 16 Kirby needles, a rubber bulb with a small irrigating tip, and vaseline are required for the operation. The radial artery above the wrist is exposed. This dissection is facilitated by having the wrist extended over a sand bag. The deep fascia is exposed and opened upon a grooved director passed beneath it through a small hole. In freeing the artery a sharp knife is used so as to make a clean dissection, and contact of instruments with the vessel is avoided as it may stimulate contraction of the muscular coats. About three inches of the artery and from three to four inches of the vein are exposed and freed. After absolute hæmostasis is established, the branches of the vessels being ligated at some distance from the main trunks, the limbs of the donor and recipient are brought into juxtaposition and loosely bound together to prevent tension on the anastomosis by movements of the patients. Serrefine clamps of suitable strength are applied centrally on each vessel,

and ligatures distally. The vessels are cut across with sharp straight scissors about one-eighth of an inch from the ligatures. The blood is quickly stripped from them, after which they are washed clean with physiological salt solution by means of a fine glass tip with smooth end attached to a rubber bulb syringe. The entire wound, especially the cut ends of the vessels, is covered with vaseline. This prevents clotting on the injured intima if any blood should escape, and is an important step in the technic. The adventitial coat of each vessel is grasped between the thumb and forefinger, drawn over the vessel end, and severed with sharp scissors; it then retracts so that it cannot be included in the suture. To facilitate the handling of the white suture material, black silk towels cover the entire field with the exception of the ends of the vessels.

The ends are approximated and held together by three retention sutures of the finest Chinese silk, which divide the circumference into three equal parts. Each of these parts is successively put upon the stretch by traction on the retention sutures, and a continuous suture is thus easily run around the whole circumference, care being exercised that each stitch avoids the adventitia but includes the media and intima at a uniform distance from the cut edge. The intima of the two vessels are thus slightly everted and brought into contiguity. Three or four stitches are sufficient along each side of the triangle. The needle and thread of one of the retention sutures, preferably that tied last, is used for the entire circuit, a single knot being made with each retention suture as it is reached. After the completion of the suture, the anastomosis is gently surrounded by a small piece of hot moist gauze, the serrefines are removed, and the blood is allowed to flow from the donor into the patient. If there be any leakage it is usually quickly checked by the gauze. If a point bleeds persistently, as in two of our cases, a stitch may be added easily and effectively while compressing the artery between thumb and finger, when slight release of pressure demonstrates the site of the leak.

If the vessels have been roughly handled or have been seized by the dissecting forceps, small constriction nodes appear, which markedly retard the flow. These may disappear after the application of very warm salt solution.

An argument in favor of the Carrel suture is that the anastomosis is not guarded by a rigid mechanical device, and can, therefore, be rolled and massaged with the rest of the exposed parts of the two vessels, if the flow appears too slow. Such stripping between the well-vaselined fingers has in our experience tended to keep the vessels dilated, thus permitting a full stream of blood. Another favorable feature of the Carrel method is that the calibre of the vessels is not diminished, and extreme dilatation at the site of the anastomosis is possible because the line of suture is on the stretch during the anastomosis. The strain is divided among many stitches, which, though frail in themselves, allow any reasonable amount of rough handling when combined. The absence of apparatus also prevents obscuring of the site of anastomosis so that any twisting of the vessels is at once apparent and can be easily corrected.

Although the median cephalic or median basilic veins may be used in adults, in infants and in children the saphenous or femoral veins are more favorable for transfusion. The position of the saphenous vein is definite, its length is sufficient, and there is no danger of injury to important structures or to the circulation of the limb; its calibre alone is questionable. In infants and young children it is too small. It seems wise, however, to examine it before exposing the femoral vein. The depth of the vein in the subcutaneous fat may cause some delay in locating it in the small subject, unless its anatomical position is definitely borne in mind. It can be readily exposed by abducting the thigh to about 65° and rotating it outward and making the incision in a line passing from slightly external to the spine of the pubes to the inner aspect of the popliteal space at the flexure of the knee. This lower limit corresponds to the posterior margin of the inner condyle of the femur. On cutting through the subcutaneous fat the

FIG. 1.



Incision for exposure of internal saphenous vein in thigh.

FIG. 2.



Internal saphenous vein exposed.

vein is found close to the deep fascia (Figs. 1 and 2). In several of our adult patients we have used the saphenous vein near the ankle.

In one case where the median basilic vein was used, it was noticed that blood flowed far more freely from the cut end of the vein after the transfusion was finished (viz., three drachms in fifteen seconds), than could have been possible during the operation. There must, therefore, have been considerable resistance in the vein. This resistance can be diminished by elevating the limb of the donor, and in Transfusion VIII this was attempted. The saphenous vein was considerably larger than the artery, and subsequently the distal inch of the latter dilated to the size of the vein. The flow was so free that pulsation could always be felt and for the most part seen in the whole of the exposed vein. The donor lay on a high operating table; after the vessels had been exposed the recipient was placed on a stretcher at right angles to the donor with her feet on the table against his chest, her head being considerably lower so that she was inclined about 45° . With the donor's arm abducted 90° it brought the vessels together in a favorable position for the operation. The inclined position seemed to facilitate the flow by diminishing resistance in the veins. It must be borne in mind that in this position overdilatation of the heart is more likely to occur.

The physiological effect of the transfusion should be noted at frequent intervals by testing the hæmoglobin, pulse, and blood-pressure. The area of cardiac dulness should be frequently mapped out, and the stethoscope freely used to detect any inability of the heart to cope with the increase in the volume of blood. Finally, considerable information as to the mechanical success of the anastomosis can be obtained by testing the blood stream through the anastomosis at the completion of the transfusion by cutting the vein and measuring the flow before ligating the artery, or by severing a communicating venous branch during the transfusion. The blood, as a rule, spurts from this as though it were a branch of the artery itself.

During the past year we have used the Carrel method twelve times in ten patients, one patient being transfused three times. The cases were secondary anæmias with the exception of Case I, which was gas poisoning, and Case V, general septicæmia. The immediate results of the transfusions were good in all except Cases V and XII. In Case V the heart was not equal to the increased burden. In Case XII the hæmoglobin did not rise, although it was shown later that the lumen was satisfactory and there was no thrombosis; on the second attempt the anastomosis was partly obstructed by a small valve-like thrombus, and free hemorrhage from the ulcerated cirroid aneurism offset the benefit from the limited amount of blood which passed. Cases II, VII, X, and XI were in almost moribund condition and were markedly improved by the operation, apparently owing their lives to the transfusion. They are all now in good health.

CASE I.—*Illuminating gas poisoning. Hypostatic pneumonia.*

C. B., New York Hospital, Medical History No. 18007. Age 52. Houseworker. Admitted February 22. Died March 1, 1909. Service of Dr. Peabody.

The patient was found by the ambulance surgeon in a room in which illuminating gas was escaping. She was comatose. Pulse was rapid and extremely feeble. Respirations were four to six per minute when she was brought to the hospital.

Physical Examination.—Fairly well-nourished woman, apparently moribund. Pupils dilated and react only slightly to light. Well-marked slow nystagmus. Tongue swollen, congested, and purplish in color. Pharynx congested and contains frothy mucus. Radial pulse almost imperceptible. Neck not stiff. Heart: slightly enlarged, sounds very distant and weak, no murmurs. Lungs: breath sounds feeble, no dulness, and no râles.

Direct transfusion was decided upon. A female patient in the accident ward, who had just recovered from an attack of acute alcoholism, offered her blood and the operation was immediately performed. The left radial of the donor was anastomosed to the median cephalic vein of the right arm of the

recipient. The blood was allowed to flow for forty minutes, the vein pulsating all of the time. The patient showed the most marked improvement. Her respirations increased from 5 to 24 per minute. The pulse became full and of a good quality. She, however, did not regain consciousness. A phlebotomy was likewise performed, 34 ounces of blood being withdrawn.

During the ensuing week phlebotomy was done several times, and salt solution per rectum and hypodermic stimulation were given. The day after the transfusion the patient's hæmoglobin was 90 per cent., white blood-cells 26,000, polymorphonuclears 90 per cent. There was albumin in the urine.

The patient gradually developed a hypostatic pneumonia and died without regaining consciousness on the seventh day after admission. Her respirations varied during this time between 24 and 44, pulse rate between 76 and 120.

In regard to the treatment of illuminating gas poisoning by transfusion, the case shows that at least astonishing temporary effects may follow transfusion. The patient was resuscitated from a moribund condition, the respirations and heart action quickly became normal and remained so for several days. The red cells of the donor must have become carriers of oxygen. In this respect the clinical findings were similar to those obtained by Crile in experiments on dogs. If the degree of poisoning is such as to cause cerebral softening, permanent benefit cannot be expected.

CASE II.¹—*Secondary anæmia—hæmophilia?*

G. M., New York Hospital, Medical History No. 18851. Age two years, 11 months. American. Service of Dr. Conner. Transferred to service of Dr. P. R. Bolton.

Family History.—No history of tuberculosis, neoplasm, syphilis, nor hæmophilia in the family of either parent. There is one older and one younger child, neither of whom has shown the slightest tendency to bleed easily.

Past History.—The patient is the second child; normal, uneventful delivery. Walked at nine months. Has had none of the diseases of childhood. While teething she had slight intestinal trouble but quickly recovered. When two years old

¹ Presented before the Surgical Section of The New York Academy of Medicine, April 1, 1910.

it was noticed that the slightest bruise left an extensive area of discoloration. Five months ago she began to have nose-bleed, which sometimes occurred in her sleep. Four months ago she fell, lacerating the upper part of her scalp. Wound was sutured by an ambulance surgeon. That night the wound began to bleed profusely, and she was taken to the House of Relief where the hemorrhage was controlled by deep sutures. The entire upper part of her face became ecchymotic.

Several severe attacks of epistaxis occurred during the following month which were controlled only after great loss of blood. She was readmitted to the House of Relief August 5, with epistaxis and weakness. August 8, red blood-cells 2,300,000, white blood-cells 18,200, polymorphonuclears 44 per cent., small mononuclears 40 per cent., transitionals and large mononuclears 16 per cent., hæmoglobin 30 per cent.

August 12: She was infused with 100 c.c. of artificial serum. This was followed by a severe chill and by a rise in temperature to 105.2°. The epistaxis which had been almost continuous was checked.

August 14: Red blood-cells 2,180,000, white blood-cells 16,500, polymorphonuclears 26 per cent., small mononuclears 71 per cent., transitionals 2 per cent., large mononuclears 1 per cent., hæmoglobin 25 per cent. No more epistaxis while in hospital. Temperature ranged between 98° and 100°. Urine was normal.

She was transferred to New York Hospital and from there to a Convalescent Home.

October 2: She was brought back to New York Hospital with persistent epistaxis. Physical examination negative excepting for epistaxis, rapid pulse, and ecchymotic spots scattered over the body. Urine negative. Nares were packed with gauze saturated with adrenalin solution, but bleeding was not controlled.

October 4: Red blood-cells 2,300,000, polymorphonuclears 63 per cent., large mononuclears 10 per cent., small mononuclears 16 per cent., transitionals 16 per cent., eosinophiles 3 per cent., basophiles 1 per cent., hæmoglobin 14 per cent., slight polychromatophilia and poikilocytosis. She was infused with 200 c.c. of artificial serum. No further bleeding for 32 hours, when she began to have profuse uncontrollable hemorrhage from the nose which almost exsanguinated her.

October 5: Transfused. Radial artery of the father was sutured to the saphenous vein of the child by the Carrel end-to-end method of anastomosis. Blood began to flow immediately but there was no visible effect on the child for 12 minutes, after which the capillaries in the conjunctivæ and ears became visible, and soon there came a tinge of pink in the child's lips and her hands became warm. At the end of 55 minutes the transfusion was stopped, the child was rosy and warm, lips red, pulse 160 and of good quality. Slight epistaxis of dark red blood began but soon ceased. Hæmoglobin readings taken every 10 minutes showed a steady rise from 14 per cent. to 68 per cent. The general condition of the patient greatly improved. The next day the hæmoglobin was 95 per cent.

Recovery was uneventful excepting for a slight bronchopneumonia of short duration and some epistaxis and vaginal bleeding. Very slight bleeding occurred twice during the following week, and once a petechial rash appeared on the face after the child strained at stool.

Discharged October 29. Cured. Hæmoglobin 89 per cent.

January 28, 1910: Patient was brought to the hospital. She had just recovered from chicken-pox of the hemorrhagic type. Small black and blue marks were present over the whole body. She had had several hemorrhages, but her condition and color were excellent.

CASE III.—*Secondary anæmia. Carcinoma of stomach(?)*.

M. Q., History Number 3409, age 41, single, housekeeper. Admitted to French Hospital, July 23, 1909. Discharged Aug. 12, 1909.

Chief complaint, pain in epigastrium, vomiting, and general weakness.

One year ago the patient began to vomit about ten minutes after taking food. The vomiting was preceded by slight nausea and was not accompanied by pain. It continued for about six months and was independent of the character of the food taken. She lost considerable flesh and became weak. She never vomited blood. For the last six months she has had pain in the epigastrium, especially after eating. The patient enjoyed good health until the present illness.

On admission the woman appeared markedly emaciated, the skin and mucous membranes were very pale. Nothing noteworthy

was found on further physical examination. Gastric analysis: quantity extracted one hour after Ewald test meal 30 c.c.; color light tan; large amount of mucus; no free blood. Free acid. none, lactic acid, moderate amount.

White blood-cells 11,000, polymorphonuclears 65 per cent., small lymphocytes 11 per cent., large lymphocytes 16 per cent., basophiles 2 per cent., eosinophiles 6 per cent., hæmoglobin 30 per cent., red blood-cells 2,210,000.

Carcinoma of the stomach was suspected. Since obstructive symptoms were not prominent, as she had ceased vomiting, it seemed wise to do an exploratory laparotomy only if her condition could be improved sufficiently to warrant a resection if this should prove indicated. On August 6, 1909, the patient was transfused. Considerable improvement resulted, but the patient decided to defer operation.

Anastomosis completed and transfusion begun at 1.15 P.M., August 6, and was terminated at 2.10 P.M. Hæmoglobin rose from 30 to 44 per cent.

After transfusion August 6 (7 P.M.), red blood-cells 3,800,000; hæmoglobin 40 per cent.

Aug. 7 (10 A.M.) red blood-cells 4,000,000; hæmoglobin 50%

Aug. 7 (7 P.M.) red blood-cells 4,400,000; hæmoglobin 55%

Aug. 9 (10 A.M.) red blood-cells 4,600,000; hæmoglobin 45%

The patient left the hospital and was told to report for examination later which she failed to do. On March 25, she died at home. No autopsy. It is said by the family physician that for four months she was in fair condition; that during the last three and a half months she failed rapidly, vomited constantly, and had severe epigastric pains.

CASE IV.—*Secondary anæmia, biliary fistula, multiple hemorrhages, senility.*

P. F., French Hospital, History Number 3546, French, age 80, admitted September 21, 1909. Died October 14, 1909.

Chief complaint, swelling and pain in inner part of the left thigh.

History.—Seven days ago patient noticed a swelling in the above mentioned region, which gradually increased. There is severe pain at site of swelling, radiating from femoral region to the knee. He is unable to stand. There is no history of

trauma. Appetite good, bowels regular, urinates three to four times daily and two or three times at night. Two days ago he says he vomited a cupful of blood.

Never had similar trouble before. Two years ago patient was operated upon for gall-stones, and the wound never closed. Has had a right inguinal hernia for 30 years. Denies urethritis and syphilis.

Physical Examination.—The scrotum, penis, and inner and posterior surface of the left thigh to the knee are ecchymotic. There is a globular swelling below Poupart's ligament on the left thigh about three inches in diameter. It is tense and tender on pressure, flat on percussion, and has no bruit. Over most of the ecchymotic area there is induration which does not pit on pressure.

The man is thin and anæmic; the arterial walls are thickened. There are a few crepitant râles and dulness at right apex in front. In the scar of gall-bladder operation there is a fistula discharging bile very freely. Just above Poupart's ligament on the left side there is a small reducible inguinal hernia. He is unable to move his left leg.

On September 23, 1909, an incision was made over the swelling on inner part of thigh; it proved to be a hæmatoma. Blood oozed intermittently from the wound. Horse serum was administered subcutaneously on three successive days without effect. There was no fever at any time; cultures of fluid from hæmatoma were sterile. Blood examination October 11, hæmoglobin 18 per cent., red blood-cells 1,856,000, blood-pressure 94 mm.

The patient was transfused on October 12, 1909; anastomosis completed and flow begun at 11.47 A.M.; flow discontinued at 12.50 P.M. Hæmoglobin rose from 18 per cent. to 39 per cent.

After transfusion: October 12 (7 P.M.) hæmoglobin 48 per cent., red blood-cells 2,380,000, blood-pressure 112 mm.

October 13 (10 A.M.) hæmoglobin 50 per cent., red blood-cells 2,900,000, blood-pressure 110 mm.

October 14, the patient had a profuse rectal hemorrhage, and died soon afterwards. No autopsy.

CASE V.—*Septic endocarditis. Septicæmia.*

A. R., New York Hospital, Medical History No. 18344.

Age 22. Milliner. Austrian. Admitted March 13, 1909. Service of Drs. Conner and Lambert. Died September 30, 1909.

Past History.—Has had no previous acute illness. No history of joint symptoms, nor sore throat. When ten years old a swelling in her neck was first noticed and she thinks that it has not grown larger since then. Thinks eyes have never been bulging; she has been nervous and excitable, and frequently has had palpitation of the heart.

Uses beer and wine moderately. Usually constipated.

No history of syphilis or gonorrhœa.

Present illness began two months ago with headache, and sharp pains in legs but not in the joints. This was soon followed by anorexia, nausea, and sharp pain over the whole abdomen which came on immediately after eating and lasted from one to two hours. At times swallowing was difficult, and she vomited sour smelling fluid which had never to her knowledge contained blood. Has had occasional sticking pains over her heart and for some time constant severe pain in the left side of abdomen.

Recently has had chilly feelings and night-sweats. No cough nor difficulty in breathing. No urinary symptoms, swelling of feet, or ankles. Has not been jaundiced. Complains of feeling very tired and weak.

Physical Examination.—Fairly well-nourished girl. Skin and mucous membranes good color. Eyes normal. Tongue moist, coated. Pharynx normal. Neck not stiff. Slight enlargement of the thyroid but no thrill nor bruit present. Diastolic pulsation is present in large veins. Systolic murmur in carotids. Pulses equal, regular, good size and force, moderate tension, Corrigan in type. Vessels not sclerosed. Capillary pulse in nails. Heart is enlarged, gallop rhythm, prolonged rather rough; diastolic murmur over aortic area. Second pulmonic accentuated. No thrills felt. Lungs normal. Abdomen soft, not tympanitic. No masses. Liver tender on percussion, normal in size. Spleen not enlarged. Kidneys not palpated. Extremities, knee-jerks greatly diminished. No œdema. No enlargement of the superficial lymph-nodes. Temperature 101.8°, respirations 24, pulse 120. Urine examination shows absence of sugar and albumin. Hæmoglobin 66 per cent., leucocytes 9000, polymorphonuclears 79 per cent., lymphocytes 21 per cent.

Blood culture taken on May 18 showed a pure culture of streptococcus. On the third day after admission she developed a systolic murmur at the apex, and on the fifth day petechial spots appeared on the front and back of chest. Abdomen became very tender and rigid. May 22 she began to receive a vaccine made from the organism obtained from her blood.

In spite of all treatment with different varieties of homologous vaccines and the usual therapeutic measures, the disease ran its course with typical waves of improvement alternating with periods of exacerbation, the up-and-down septic temperature, enlarged spleen, nephritis, petechiæ, etc.

Her brother, a healthy young man, consented to be the donor for a transfusion. He was prepared by vaccination with the vaccine made by Dr. Elser, pathologist to the New York Hospital, from the streptococcus of her blood, the purpose being to produce antibodies in his blood antagonistic to that organism.

September 11, 1909. Transfusion. Service of Dr. Bolton. Several ounces of blood were first drawn from the patient's veins. The radial artery of the donor was then sutured to the left internal saphenous vein of the recipient. The anastomosis was perfect; blood flowed freely and apparently at a good volume. After ten minutes the patient became restless, irrational, cyanosed, her pulse rapid and irregular, and respirations rapid and almost stertorous. It seemed extremely dangerous to continue, so the transfusion was immediately stopped. She was stimulated by hypodermic injections and in a few hours she had recovered fairly well.

During the next week the patient developed general œdema. Showers of emboli, causing pain in the internal organs, and petechiæ continued, and the patient's asthenia became marked. She died on the nineteenth day after transfusion, after an illness of almost eight months. No autopsy.

CASE VI.—*Secondary anæmia following puerperal septicæmia.*

V. M., French Hospital, History Number 3665, married, age 30, Italian, housewife. Admitted October 22, 1909, discharged December 3, 1909.

For the last seven weeks, patient has complained of pain in left side of abdomen and back, pain is severe in character and radiates over lower part of abdomen. Urinates somewhat too

frequently, bowels irregular, appetite poor. She has lost considerable weight and feels very weak.

Was operated upon elsewhere, on August 31, 1909, for "puerperal septicæmia." The operator sends the following details: "Temperature 105°, pulse 130, respirations 30 before the operation. There was a large intramural abscess on the left side, extending into broad ligament and including left tube and ovary. The sigmoid was included in adhesions and slightly eroded. Patient's condition permitted only a rapid laparotomy and drainage. Fecal fistula appeared on fourth day. After operation and for some days subsequently, the pulse ran from 136 to 128. Temperature 104° to 100° and respirations 60 to 30."

Physical Examination.—Patient is very feeble, pale, and emaciated. Heart negative. There are a few sibilant râles at the right apex. Abdomen: There is a wound about three inches long in the left lower quadrant of the abdomen discharging pus and fæces. The entire abdomen is tender to palpation, especially on the left side where a mass is indefinitely felt. By vagina extensive induration is appreciable in the left side of pelvis. There is a profuse purulent vaginal discharge.

Urine: Turbid, flocculent precipitate, specific gravity 1026, acid, albumin present, considerable pus and amorphous urates. Blood examination on October 24, hæmoglobin 30 per cent.; red blood-cells 2,384,000; white blood-cells 8500; polymorpho-nuclears 74 per cent.; small lymphocytes 20 per cent.; large lymphocytes 3 per cent.; basophiles 2 per cent.; eosinophiles 1 per cent.

The patient's condition was so poor that a transfusion was done in the hope of making her better able to stand an operation. Improvement was marked and operation was repeatedly deferred.

Transfusion, October 25, 1909. Anastomosis completed and flow begun at 11.07 A.M.; flow discontinued at 11.58 A.M.

	Time	Recipient
Blood-pressure (systolic)	10.00 A.M.	110 mm.
	11.20 A.M.	124 mm.
	11.40 A.M.	115 mm.*
	12.00 M.	150 mm.

*At this sudden fall in blood-pressure apex of heart had moved $\frac{1}{2}$ inch to left; volume of flow was diminished for five minutes and heart gradually resumed its normal outlines.

	Time	Recipient
Pulse.....	10.00 A.M.	108
	10.30 A.M.	104
	11.00 A.M.	96
	11.30 A.M.	92
	12.00 M.	84
	12.15 P.M.	88
Hæmoglobin.....	10.00 A.M.	34 per cent.
	11.15 A.M.	45 per cent.
	11.40 A.M.	47 per cent.
	12.00 M.	50 per cent.
	12.15 P.M.	50 per cent.

After cutting vein, three drachms of blood flowed in fifteen seconds.

Oct. 25 (8 P.M.): Hæmoglobin 54 per cent.; red blood-cells 3,608,000; blood-pressure 119 mm. Improvement continued steadily until Nov. 1, when hæmoglobin was 62 per cent.; red blood-cells 4,600,000; from the 1st to the 20th there was a steady fall; November 20, hæmoglobin 42 per cent.; red blood-cells 3,300,000. No operation was performed, and at the time of her discharge the fecal fistula was almost closed, the pelvic and abdominal masses had greatly diminished, and her general condition was so good that she was able to return at once to her household duties.

TRANSFUSIONS VII, VIII, and IX.³—*Anæmia* (transfused three times).

M. T., French Hospital, Admission Number 15,399, age 43, French, married, housewife. Admitted December 29, 1909.

Present History.—Onset, 14 days ago, began with violent headache, pain in back, over heart, and in epigastrium, and extreme weakness; a day later slight jaundice appeared; she has been confined to bed since onset.

Previous History.—In 1896 patient had menorrhagia for which she was curetted; in 1900 she was operated upon for an abscess on the left side of thorax; in 1902 she had rheumatism which confined her to bed one month. She has had at times a distressing cough and dyspnoea for a number of

³ Presented before the New York Surgical Society, May, 1910. We are indebted to Dr. Shanley, house surgeon of the French Hospital, for the records of the cases at that institution.

years, also palpitation on the slightest exertion, but no night-sweats, chills, or fever; she has had œdema of legs for nine years, gradually increasing to date; also frontal headaches, worse at night and throbbing in character, spots before the eyes, vertigo, and tinnitus for the past three or four years. Gives no history pointing either to gonorrhœa or syphilis. For past two years patient has been under severe mental strain. Eighteen months ago she began to lose her color, the pallor has gradually increased. Menses began at fourteen years and were regular until 25 years of age, since then they have been profuse much of the time, lasting five to eight days, and making her very weak for some time following. The menorrhagia has been especially marked recently. Married at twenty-five; two children living and well; no miscarriages. Habits good.

Physical Examination on Admission.—Woman of medium size, apathetic, and aroused with difficulty. Face expressionless, mucous membranes colorless, lips dry, parched, and brown, conjunctivæ slightly yellow, skin has a lemon tint and is bloodless, superficial veins show conspicuously as dark blue lines. Radial pulse not palpable, heart sounds very feeble. The woman appears moribund. Blood examination shows 600,000 red blood-cells and 16 per cent. hæmoglobin. Urine, December 29, 1909: turbid, amber, flocculent precipitate, specific gravity 1016, acid, no sugar, moderate amount of albumin, numerous epithelial and red blood-cells, few white blood-cells, many hyaline and granular casts.

Transfusion was immediately done, taking the husband as donor, although he was weak and anæmic. There was moderate improvement. The next day a second transfusion was made, taking a young man as donor. Marked improvement resulted. Cheeks became flushed, lips of a normal color. The recipient, however, became extremely restless and it was necessary to stop. Afterwards she became delirious and two days later showed extreme jaundice.

The third transfusion was done ten days later, as the patient's blood and general condition had begun to show a marked change for the worse. A healthy young man was used as the donor. Considerable and prolonged improvement resulted.

Record of *first transfusion*, December 29, 1909:

Before transfusion, red blood-cells 600,000, hæmoglobin 16 per cent., blood-pressure 100 mm.

Flow begun at 1.21 P.M., discontinued at 2.15 P.M.

		Donor	Recipient
Blood-pressure.....	{ Beginning..	130	99
	{ End.....	119	128
Pulse.....	{ Beginning..	88	128
	{ End.....	92	122
Hæmoglobin.....	{ Beginning..	71 per ct.	16 per ct.
	{ End.....	57 per ct.	22 per ct.
Red blood-cells.....	{ Beginning..	3,600,000	600,000
	{ End.....	2,700,000	928,000

December 29, 7 P.M.: Red blood-cells 1,008,000, hæmoglobin 21 per cent., white blood-cells 42,000, polymorphonuclears 69 per cent., small lymphocytes 16 per cent., large lymphocytes 13 per cent., basophiles 2 per cent., megaloblasts 5 per cent., normoblasts 7 per cent., marked poikilocytosis, numerous umbilicated red cells. Stools negative for ova, occult blood, etc.

Second transfusion, December 30, 1909. Transfusion flow begun at 5.03 P.M., discontinued at 6.11 P.M.

After transfusion vein was cut and in 14 seconds there flowed 110 minims.

		Donor	Recipient
Blood-pressure.....	{ Beginning..	128	111
	{ End.....	100	136
Pulse.....	{ Beginning..	82	120
	{ End.....	124	104
Hæmoglobin.....	{ Beginning..	81 per ct.	19 per ct.
	{ End.....	65 per ct.	33 per ct.
Red blood-cells.....	{ Beginning..	4,100,000	1,015,000
	{ End.....	3,018,000	1,952,000

Subsequent to transfusion: December 31, 7 P.M.: Red blood-cells 2,288,000, hæmoglobin 35 per cent., white blood-cells 18,700, polymorphonuclears 72 per cent., small lymphocytes 8 per cent., basophiles 1 per cent., normoblasts 6 per cent., megaloblasts 3 per cent., marked poikilocytosis and numerous umbilicated red cells.

January 9: Red blood-cells 1,236,000, hæmoglobin 25 per

cent., white blood-cells 11,900; otherwise the counts taken each day were about the same as that last given.

Third transfusion, January 10, 1910. Flow begun at 6.16 P.M., stopped at 6.55 P.M.

	Donor	Recipient
Blood-pressure.....	{ Beginning.. 120	92
	{ End..... 102	125
Pulse.....	{ Beginning.. 72	136
	{ End..... 92	120
Hæmoglobin.....	{ Beginning.. 100 per ct.	23 per ct.
	{ End..... 94 per ct.	56 per ct.
Red blood-cells.....	{ Beginning.. 5,150,000	1,184,000
	{ End..... 3,746,000	1,386,000

After this the patient did fairly well, although she developed a pneumonia in lower right base and later pleurisy with effusion on left side. This made necessary repeated tapplings (10 in all), at times 20-30 ounces of clear or blood-tinged fluid being removed.

March 5: Von Pirquet test negative.

March 13: Patient has been up for some days, can walk, has fair appetite, and feels well. Urine occasionally shows trace of albumin. Red blood-cells 2,624,000, hæmoglobin 70 per cent.; the blood is otherwise normal.

May 7: Patient in good condition, hæmoglobin 70 per cent.; red blood-cells 3,150,000.*

CASE X.—*Papilloma of bladder. Excision. Secondary anæmia.*

J. S., the Post-Graduate Hospital, service of the late Dr. Follen Cabot. Male, age 34 years. Admitted January 20, 1910.

Chief complaint, pain in left side of abdomen and bloody urine.

*The cause of the anæmia in this case could not be definitely determined.

Dr. N. B. Potter, who supervised the treatment much of the time, wrote, "Her blood picture has not been one of typical pernicious anæmia; how much, however, it has been altered by the transfusions no one can say. Very grave anæmia with a persistently high color index is as near as I can get."

Dr. F. C. Wood wrote, "I would not like to make a positive diagnosis of pernicious anæmia on the smears, but would prefer to call the condition a secondary anæmia."

Past History.—Has had several previous attacks of hæmaturia, otherwise the history is unimportant.

Present Illness.—Blood appeared in the urine nine days ago and has been steadily increasing in amount since. There has been pain in the left lumbar region and in the end of the penis during urination. Patient has had great difficulty in urinating during the past three days.

Physical Examination.—Patient is a large, well-nourished Italian, showing nothing abnormal on external examination excepting extreme pallor. Specimen of urine contains almost pure blood.

Operation by Dr. Cabot, January 21. Suprapubic cystotomy. Excision of papilloma of the bladder. Rubber drainage tube left in the bladder. Operation begun with eucaine local anæsthesia and completed under nitrous oxide gas anæsthesia. Duration, one hour. General condition of patient very poor. Pulse weak and rapid after the operation.

Five and a half hours after the operation the patient was comatose and practically moribund. Hæmoglobin 34 per cent., red blood-cells 1,500,000, pulse 156 per minute.

Transfusion was performed by one of us (R. D. McC.) with the assistance of Dr. Aspinwall Judd. The donor was a brother and of only about two-thirds the stature of the patient. The right radial artery of the donor was anastomosed to the left internal saphenous of the recipient. The vessels were exposed and anastomosed in 28 minutes. The blood was allowed to flow 40 minutes.

The following table was made during the operation. At 5.30 P.M. flow of blood started.

	Hæmoglobin	Pulse
5.40 P.M.	36 per cent.	132
5.45 P.M.	42 per cent.	126
5.50 P.M.	53 per cent.	126
5.55 P.M.	54 per cent.	126
6.00 P.M.	58 per cent.	126
6.05 P.M.	62 per cent.	126
6.10 P.M.	62 per cent.	126

Transfusion ended, 6.10 P.M.

The patient's general condition and color underwent marked improvement during the transfusion. The transfusion would have been continued but the donor began to show the effect of

the loss of blood. He became very pale, restless, and nauseated. Eight P.M., the same day, hæmoglobin 64 per cent., pulse 140.

January 22, 10 A.M.: Red blood-cells, 3,320,000, hæmoglobin 76 per cent. General condition is greatly improved and patient is mentally much brighter.

January 26: Red blood-cells 3,170,000, hæmoglobin 71 per cent.

February 11: Red blood-cells 3,616,000, hæmoglobin 75 per cent (Talquist).

All of the previous readings had been taken with the Dare hæmoglobinometer. March 3d. Red blood-cells 4,112,000, hæmoglobin 75 per cent. (Talquist). The condition of the patient is good and he is ready to leave the hospital.

CASE XI.³—*Infected fibroid of uterus. Suppurative metritis. Multiple metastatic abscesses of thigh. Pyæmia.*

New York Hospital, service of Dr. Bolton. Surgical History No. 38,247, Mrs. J., 35 years, admitted August 3, discharged November 4, 1909.

Past History.—Has always been strong and healthy. Menstruation began at seventeen years of age, regular, every five weeks, not painful. Married at twenty-one. First three pregnancies terminated successfully.

Present Illness.—On July 7 patient had a miscarriage and stated that it was not induced. Her last period had been in May. Following the miscarriage she had persistent bleeding and the discharge soon became very foul. She had chills and a high fever. She became so ill that she did not remember much about the early part of her sickness. Her physician gave her intra-uterine douches. Bleeding soon stopped, but she continued in a very serious condition and was brought to the hospital.

Physical Examination.—Patient is an extremely anæmic woman. She is weak and appears septic. Head: face and mucous membranes are almost bloodless. Tongue is slightly coated, teeth are very bad. Heart percusses normal. Sounds are distant and weak and there is a systolic murmur at apex, transmitted toward axilla, not well heard in back. Lungs:

³ Presented before the Surgical Section of The New York Academy of Medicine, April 1, 1910.

normal. Abdomen: not distended or tender. Just above the symphysis and to the right of midline, there is a slight rounded prominence. On palpation it is found to be firm and freely movable. There is a slight resistance above the limit of this mass.

Vaginal Examination.—Outlet normal for multipara. Marked discharge of pus. The cervix is large and soft. The external os is dilated and emits a profuse discharge of pus. Bimanual examination reveals a large, firm, elastic, fairly movable mass without fluctuation extending upward from the right side of the uterus. Tubes and ovaries are indefinitely palpable.

Temperature 102°, pulse 124, respiration 28. Hæmoglobin 30 per cent., leucocytes 40,000, polymorphonuclears 84 per cent., mononuclears 13 per cent., transitionals 3 per cent. The red cells show considerable poikilocytosis. No nucleated reds found.

The general condition of the patient was such that it was thought she could not stand an operation. She did not improve under treatment but became weaker. October 9 her white blood-cells numbered 16,000, and her temperature reached 104.8°.

A brother willing to give his blood offered himself and a transfusion was decided upon. Patient's hæmoglobin was now 18 per cent.

August 10: Transfusion was unsuccessfully attempted by others by Hartwell's implantation method, with a Crile cannula and by suture. Clotting occurred in the first two attempts, considerable hemorrhage in the last, which was not controlled until a clot had formed.

August 11: Transfusion was performed following Carrel's technic of end-to-end blood-vessel suture. The right radial of the donor and the right internal saphenous vein of the patient were prepared under local novocaine anaesthesia. Anastomosis was easily made. There was slight bleeding at the line of union, but this quickly stopped without further suture. Pulsations were palpable in the vein. The calibre of the vein remained small for about fifteen minutes, when the vessel began slowly to dilate and the blood flowed more freely. The hæmoglobin rose gradually but with a marked acceleration toward the end of the operation, from 18 to 40 per cent. The transfusion was stopped when the donor became restless and vomited several times. The patient's mental condition had improved.

Her lips at the beginning were colorless, but were now red and her cheeks had gained a healthy pink.

The anastomosis was opened and found perfectly patent. No thrombosis. The afternoon of the transfusion a dull curettage was done and some tissue and considerable pus were brought away. Uterine irrigation given. The pathologist reported the specimen to be well-preserved muscle tissue. For a few days the condition of the patient was excellent, but soon she became weaker and her hæmoglobin dropped within six days to 18 per cent., the same as before transfusion. Spectroscopic examination failed to reveal a trace of bile or blood pigments in urine. On August 15 her general condition was about the same as before transfusion. The mass in the lower abdomen was markedly diminished in size, and there was an absence of tenderness and rigidity in lower abdomen. White blood count, 24,000, polymorphonuclears 84 per cent., red blood-cells 1,800,000, temperature ranged around 101°. Transfusion wounds healed.

The following abstracts from the bedside notes outline the subsequent course.

August 17: General condition is very much improved. She takes food by mouth and retains nutrient enemata. She feels much stronger. Discharge from vagina remains profuse with extremely unpleasant odor. Small necrotic mass expelled from uterus. Uterine tumor much decreased in size.

August 29: Very slight uterine discharge. Uterus is now small, fairly firm, and movable. Mass is no longer felt in its wall. Cervix normal. Hæmoglobin is rapidly rising. Yesterday she had two chills, followed by elevation of temperature to 105°, accompanied by severe nausea and vomiting.

September 12: Hæmoglobin 50 per cent. Patient feels stronger and looks better, though she has had numerous chills with sudden rises and falls of temperature during the last few days.

September 29: Pain has persisted in the right thigh and calf. There is slight swelling with some fluctuation and increased surface temperature on inner side of right thigh just above the knees. She has been having chills and considerable fever.

September 30: Incision made over inner side of right thigh and a considerable quantity of pus evacuated. Drainage.

October 8: A few petechiæ have appeared on chest, arms, and back. Daily rise of temperature and frequent chills persist. The petechiæ followed an attack yesterday in which she complained of a peculiar sensation over entire body, and pain in back which lasted about six minutes. Over bases of both lungs are subcrepitant râles and a few râles are present anteriorly. No pain over spleen or kidney regions. Patient vomits frequently and vomitus contains bile. Sinus is discharging freely. Pathologist reports original culture from thigh sterile. Hæmoglobin has gone down to 45 per cent. Blood cultures continue negative.

October 15: Temperature has been normal for two days, and she feels much better and is taking more food. Sinus is healing slowly. She is now receiving dead staphylococci injections with no local or general reaction.

October 23: Gaining in strength daily. Has had no rise of temperature for five days. Is now taking food of from 1800 to 2200 calories value daily as advised by Dr. Conner.

October 31: Is now able to walk with assistance. Hæmoglobin 53 per cent.

November 4: General condition good. No pain, fever, or chills. Is gaining in weight and is able to walk alone. Pelvic examination negative. Uterus normal in size and there is no discharge. No tenderness on palpation. Wound in thigh is practically healed.

Diagnosis: Infected myoma of uterus, suppurative metritis. Metastatic abscess of thigh, septicæmia? Result: Cured. Patient discharged to go to the country.

Patient seen in December, is in perfect health. Has gained in weight even to excess. Color is that of a robust healthy woman.

CASE XII.—*Secondary anæmia, following hemorrhage from cirroid aneurism of face.*

I. G., New York Hospital. Surgical History No. 39,607. American girl, age 22. Admitted February 18, 1910. Service of Dr. Hartley.

Patient was born with a large vascular nævus over the left side of face, involving also the left ear which has always been larger than the right. The nævus grew and greatly disfigured the face and ear. Five years ago both carotid arteries were

ligated. Since then the mass has steadily increased in size, though more rapidly during the past two years. Eighteen months ago the ear became ulcerated, and foul-smelling pus has been continually discharged. Several severe hemorrhages have been checked with the greatest difficulty.

She is now suffering from pain, loss of appetite, loss of weight, nervousness, and anæmia.

Physical Examination.—Rather large girl with marked anæmia. There is a large pulsating tumor involving the left side of the face, scalp, and ear, which is about five times the natural size and much distorted. Immediately under the skin the tortuous outlines of large vessels are plainly visible. The lower half of the growth is ulcerated and emits a foul odor. The auditory canal is obliterated, and the sense of hearing is absent on this side. A loud systolic murmur is heard over the entire surface of the growth.

After admission to the hospital several hemorrhages occurred which were checked only by tight bandaging. Anæmia became marked and weakness extreme. Hæmoglobin readings fluctuated between 19 and 40 per cent.

On February 21 transfusion was performed. The donor was a highly neurotic sister who so excited the patient during the operation that an almost fatal hemorrhage occurred. The radial artery was first anastomosed to the saphenous vein near the ankle. As the flow was not satisfactory, a second anastomosis was made with the cephalic vein.

The transfusion resulted in little benefit, the hæmoglobin at the end reading only a few points higher than at the beginning. The loss of blood during the transfusion as the result of hemorrhage from the ulcer was very free, therefore it is likely that the hæmoglobin readings were not a true index of the amount of blood which passed.

The patient was discharged from the hospital March 29 unimproved.