of these was the sucking in of the bellows, with consequent chafing, necessitating frequent repair of punctures and eventually replacement of the bellows. Mr. Paul has entirely got over this difficulty by providing for a shorter length of stroke ($2\frac{1}{4}$ inches instead of $3\frac{1}{4}$ inches), and certain other modifications have also been incorporated to ensure almost noiseless working of the apparatus. One other improvement is the inclusion of a two-way connexion which readily allows two children to be treated in the apparatus simultaneously—a direct development of the improvised arrangement we made in Cork Street two years ago. Another important improvement in the belt is the addition of shoulder-straps, which will prevent the belt from slipping down over the abdomen, an eventuality that had to be constantly watched for with the older belts. The fastening of the new belt is by means of a chain clip, which is also an improvement on the older buckles.

Conclusion

The Bragg-Paul pulsator is an efficient artificial respirator which is specially adapted to the treatment of post-diphtheritic respiratory paralysis or respiratory paralysis due to anterior poliomyelitis. It is also of use in restarting respiration which may be reflexly stopped during the operation of tracheotomy or during any operation where such reflex stoppage may be anticipated. It has been used, too, to re-expand a lung and cause healing of a chronically discharging empyema. The new model is a more compact and a neater apparatus than the original, and promises to have even greater efficiency as an artificial respirator.

TRANSFUSION WITH STORED BLOOD

BY

T. I. WILSON, M.B., F.R.C.S.Ed.

Clinical Tutor, Royal Infirmary, Edinburgh

AND

J. M. M. JAMIESON, M.B., Ch.B.

Late House-Surgeon, Royal Infirmary, Edinburgh

Transfusion with stored blood has been practised for many years, and during the great war it was used particularly in the front-line hospitals of certain Dominion medical units. Thereafter the practice appears to have fallen into disuse, but was revived again more recently by Russian surgeons, who use blood taken from the cadaver within a few hours of death. It is also recorded that certain supplies of stored blood have proved of great value in the course of the present civil war in Spain.

This paper contains details of fourteen cases of blood transfusion exemplifying the value of having a supply of blood in cold storage, ready for immediate use. The field of investigation has been purely a clinical one, and our observations have been limited to the general reaction of the patient to the treatment carried out. The indications for transfusion, in the cases here recorded, were, for the most part, weakness and anaemia associated with sepsis and malignant disease rather than the replacement of blood loss by haemorrhage, which was present in only three instances.

The Source of Supply

The source of supply has varied; two patients with polycythaemia were generous donors, and in the other cases the blood was obtained from healthy individuals.

In all except one case the blood was Group IV in type, and in each instance the citrate method was employed, the concentration of sodium citrate being 0.38 per cent. in the stored blood.

Technique

The blood is withdrawn from the donor's cubital veins under strict aseptic conditions, and is collected in sterilized flasks containing the required amount of sodium citrate solution for the quantity of blood withdrawn. A pint of blood is thus collected in each flask, which is closed with a sterile plug of gauze and wool, and then sealed and labelled. This supply is stored at once in a refrigerator at a temperature of -10° to -3° C. In our series of cases the stored blood has been used after a period of from four to thirty-eight days.

Serological tests are carried out upon all donors, and before use the patient's serum is typed directly against the corpuscles of the stored blood. On examining the stored blood microscopically, even as late as five weeks from the time when it was originally put on ice, the erythrocytes were observed to be normal in appearance in every way, except for a few which showed crenation. During storage, sedimentation of course occurs, and before use the flask is gently agitated to mix the cells again with the plasma. The method wherein sterile glass balls are placed in the flask to promote more thorough mixing we do not favour, as this tends to break down many of the cells.

After mixing the blood thoroughly, it is decanted into a sterile measure through a filter composed of layers of gauze. This filter is necessary, because late clotting tends to occur in citrated blood in certain cases, and clots must of course be eliminated. The blood is infused into the recipient's circulation, through a vein in the arm, by means of a funnel, tube, and glass cannula. It is given unheated, the reason being that heat would appear to cause an alteration, possibly of the protein content, and toxic symptoms may follow the administration of blood so treated. Our practice is to give the blood after it has stood at room temperature for a period of from half to one hour. The flask is then still cold to the touch. In the cases reported below only two were followed by a reaction, and in these the blood had been heated to "normal" temperature. It is significant in this connexion that we have observed reactions follow immediate transfusions in cases where the flask of blood has been placed in warm water.

The second precaution to be taken in administering the blood is to ensure that the rate of flow is even and slow. We endeavour to occupy a period of about fifty minutes in giving one pint of blood, this representing a quantity of just over 10 c.cm. per minute. This rate of flow is frequently diminished by spasm of the vessel induced by the cold blood.

Case Records

Case 1.—A man aged 49 suffering from carcinoma of the colon with peri-neoplastic abscess, was admitted with acute obstruction. Colostomy was performed and, later, resection. The first transfusion, one pint of Group IV blood five days old, was given on October 15, 1936, and a second transfusion, one pint of Group IV blood twenty-one days old, was administered on December 7. There were no reactions, and the patient is now alive and well.

Case 2.—A man aged 50 with carcinoma of the urinary bladder. The ureters were transplanted into the colon and total cystectomy was performed. The first transfusion, given on October 18, 1936, was one pint of Group IV blood eight days old; the second transfusion, on November 13, was half

a pint of Group IV blood seven days old. No reactions occurred.

Case 3.—A man aged 42, admitted with congenital polycystic disease of the kidneys and profuse haemorrhage. The first transfusion, on November 30, 1936, consisted of half a pint of Group IV blood twenty-four days old. The second transfusion, on December 9, was of one pint of Group IV blood ten days old. The first transfusion was followed by a transient reaction of the "rigor" type, but there was a marked reduction in the haematuria. The blood used in this transfusion had been heated to "normal" temperature. Nephrectomy had to be performed, however, and the blood loss was made good by the second transfusion. The patient is now alive and well.

Case 4.—A man aged 47 with perforated duodenal ulcer treated on admission by simple closure. Haematemesis occurred on the same evening. On December 11, 1936, half a pint of Group IV blood four days old was transfused. The patient had no immediate reaction, but bleeding recurred and he died.

Case 5.—A woman aged 49 suffering from chronic cholecystitis with acute cholangitis and abscesses. Cholecystectomy was performed on January 17, 1937. The first transfusion (January 16, 1937) was of three-quarters of a pint of Group IV blood twenty-two days old. The second transfusion (January 17) was of half a pint of Group IV blood twenty-three days old. There was no immediate reaction and the patient's condition was much improved after the post-operative transfusion. Her myocardium failed, however, and she died on the following day.

Case 6.—A man aged 30. This was a case of subphrenic abscess in a patient with spastic diplegia. The transfusion (February 24, 1937) was of one pint of Group IV blood ten days old. No reaction occurred, and the patient is now alive and well.

Case 7.—A man aged 68 with renal adenocarcinoma. Nephrectomy was performed, and a large tumour was dealt with. Transfusion (January 20, 1937) consisted of half a pint of Group IV blood thirty-eight days old. No reaction occurred. There was a definite improvement in the patient's general condition, but hypostatic pneumonia developed and death took place seven days later.

Case 8.—A man aged 60 with suppurative tenosynovitis and septicaemia. The patient was very ill. Transfusion (February 28, 1937) consisted of one pint of Group IV blood twenty-eight days old. This produced a definite general improvement; there were no reactions. The condition became progressive, however, and death occurred, with pyaemia and multiple abscesses, sixteen days later.

Case 9.—A woman aged 64 with carcinoma of the urinary bladder. The ureters were transplanted into the colon. A transfusion of one pint of Group II blood five days old was given on June 13, 1937. The patient showed marked improvement at the time but died three weeks later from bronchopneumonia.

Case 10.—A woman aged 24. This was a case of secondary haemorrhage in acute puerperal mastitis. Half a pint of Group IV blood thirty-five days old was transfused on June 27, 1937. A slight reaction of "rigor" type followed, but satisfactory progress was obtained thereafter. The patient is now alive and well. The blood in this case was heated to "normal" temperature.

Results

It will be seen that these ten patients had between them fourteen transfusions. Two deaths occurred in the period immediately following transfusion, one from syncope and the other from recurrence of haemorrhage. In three other cases the outcome was eventually a fatal one. None of these cases showed any reaction in the immediate post-transfusion period, and in no case could the fatal result be attributed, in any degree, to the administration of stored blood.

Five of the patients—comprising eight transfusions—are alive to-day, and among these are the two cases in which reactions occurred.

Summary

1. Fourteen instances of delayed transfusion with stored blood are recorded.
2. The technique and method of storage are described.
3. The precautions to be observed are instanced.
4. The safety of the practice is demonstrated.

We desire to express our thanks to Mr. Henry Wade, in whose wards these cases were treated, for his permission to publish these records. We are further indebted to Mr. Wade and to Sir David Wilkie for their interest and help.

Clinical Memoranda

Spontaneous Cerebrospinal Rhinorrhoea

Escape of cerebrospinal fluid from a nostril is a rare condition. A review of the literature revealed only sixty-six cases reported up to 1934, and of these many were secondary to definite cerebral conditions.

Aetiology.—Excluding fractures of the base of the skull, where the cause is obvious, and long-standing cases of increased intracranial pressure, either from tumour or from hydrocephalus without tumour, the cause of spontaneous cerebrospinal rhinorrhoea has not been clearly established. This is due to the fact that necropsy was performed on a limited number of cases only. In some of these the post-mortem findings were entirely negative, while in others the picture was masked by secondary infection. A tiny opening, however, was reported to have been found in the cribriform plate, and the prevailing theory attributes the condition to a congenital defect in the base of the skull—namely, a "cranio-pharyngeal canal" which is forced open by slight trauma or violent coughing or sneezing. McDougal thinks that the cerebrospinal fluid tracks down the perineural sheaths of the olfactory nerves.

Symptoms.—The patient complains of a continuous watery discharge from one nostril. The flow is persistent, but may be altered by the position of the head, being increased when the head is bent forward and diminished in the upright position. On lying down it is swallowed. The fluid can be seen to come down from the upper pole of the nasal cavity between the septum and the middle turbinal.

Diagnosis.—This is established by complete examination of the fluid, which should have the same composition as cerebrospinal fluid. Constantine introduced a solution of fluorescein by lumbar puncture, which appeared one and a half hours later in the fluid from the nose. Lumbar puncture, a procedure not without danger, should be done with a fine needle, and very little fluid drawn.

Prognosis.—Unfortunately in the majority of cases on record the outcome of this condition is not stated. Many cases proved fatal as a result of intervention. In some cases, as in that reported below, the flow ceased spontaneously with rest in bed. Recurrence of the symptoms may take place many years later.

Treatment.—As spontaneous cessation of the flow may occur with expectant treatment absolute rest in bed should be tried in all cases that are without apparent cause. If this fails, or in cases of recurrence of the leakage, a cranial operation must be advised. This consists in