bottles of sedimented blood were carried in an ambulance for six or eight miles over rough roads without any damage to the cells. There was a slight stirring up of the surface of the sedimented layer, which coloured the supernatant fluid to a moderate degree. Judging by the colour, this contained perhaps 10 c.cm. of suspended blood cells, not more. Thus, if the blood had been used immediately after transportation, very little would have been lost in the siphonage. On standing, the blood cells soon settled, leaving a clear fluid above. It was considered possible that the red blood cells below the surface might have been injured during transit and the resulting haemolysis concealed in the deeper layers. Accordingly, the whole sediment was thoroughly stirred up, then allowed to sediment. As before, the supernatant fluid showed no sign of haemolysis.

SUMMARY.

As first found by Rous and Turner, it is possible to preserve living human red blood cells for several weeks in a solution of dextrose and citrate, when kept at ice-box temperature. This method of keeping blood has been made use of recently for giving transfusions at casualty clearing stations during a rush period. A quantity of blood was stored up beforehand ready for use when needed. The blood was kept for varying periods up to twenty-six days before transfusion. Twenty-two transfusions were given to twenty cases by this method. The majority of these were cases of haemorrhage. The results of preserved blood transfusion were quite as striking as those seen after transfusion with blood freshly drawn. There was the same marked improvement, the patients stood operation well, and subsequent progress was quite as good as in those cases transfused by the usual methods. The introduction of kept red blood cells had no apparent harmful effect, as there were no reactions or evidence of increased haemolysis after transfusion.

The chief advantage of this method over other methods of transfusion in current use is the great convenience of having a stock of blood on hand for busy times. The transfusions can be given relatively quickly, and the technique, which is simple and easily acquired, can be carried out entirely by one medical officer.

Experiments in the transportation of preserved blood have shown that it can be carried a considerable distance without injury.

REFERENCES.

¹ Peyton Rous and J. R. Turner, *Exper. Med.*, 1916, xliii, 219. ² Major R. I. Lee, *BRITISH MEDICAL JOURNAL*, November 24th, 1917. O. H. Robertson, "Transfusion at Casualty Clearing Stations" (not yet published).

BLOOD TRANSFUSION IN A FIELD AMBULANCE.

BY

CAPTAIN NORMAN M. GUIOU, C.A.M.C.

THE work described in this article was undertaken as the result of lectures delivered by Major McNee and Captain Sladden, R.A.M.C., and Major Harrison, C.A.M.C., and is an endeavour to show that the operation of blood transfusion is *easily* applicable to the forward area, where it is most needed.

Group Testing.

As the mobile laboratory was busy preparing serums for casualty clearing stations, a few cubic centimetres of II and III serums were obtained from the Lister Institute. A group of dressers of different sections was assembled and shown the macroscopic test as used by Major McNee. A drop each of II and III serums are placed at opposite ends of a slide, and into these are stirred small quantities of blood picked up in the eye of the needle used for pricking the finger. After rocking gently, the slide is covered with a Record syringe box lid for four minutes, rocked again, allowed to stand another minute, and then read. After two demonstrations the dressers could do the test, and proceeded under supervision to test one another and their comrades. Stock serums were prepared from a clear-cut II and III by bleeding into a 2 oz. conical graduate, loosening the clot round the top one hour later with a probe, and next morning transferring the supernatant serum to boiled antitoxic serum bottles with an eye dropper and

adding one drop of 5 per cent. carbolic for every ten drops of serum. These bottles, together with two eye droppers marked II and III and a safety-pin box of slides, fitted easily into an ordinary oblong cigarette box. On the inside of the lid the following table was pasted:

	Red Blood Cells.	Red Blood Cells.	Red Blood Cells.	Red Blood Cells.	Frequency of Group.
	1	2	3	4.	Per cent.
Serum 1 ...	—	—	—	—	8
Serum 2 ...	+	—	+	—	40
Serum 3 ...	+	+	—	—	10
Serum 4 ...	+	+	+	—	42

+ = Agglutination. — = No agglutination.

The important point is the effect of the patient's plasma on the cells to be introduced.

This test case fitted readily into one of the spaces in the field medical pannier allotted to tubes of vaseline. With it a dresser could determine the blood group of a volunteer and a patient in a few minutes.

The Operation.

The syringe method with glass cannulae in the veins was used; needles were tried once, but the dresser assistant got his out of the vein and trouble resulted. Two inches of the thick-walled rubber tubing of the aspiration set were fitted to each cannula, one inch being free to receive the end of the syringe. Five per cent. carbolic was used for numbing and sterilizing the skin; the veins were dissected out and ligatures placed by the medical officer, and then he and the dresser together cut their respective veins and introduced the cannulae—that in the donor being directed distally. The cannulae were held in place and blocked by pinching the rubber tubing. The 20 c.cm. glass syringes, four in number, fitted snugly into the rubber connexions and were kept going in a cycle, being washed out each time in a vessel of boiled saline by a second dresser, and laid on a piece of sterile gauze ready for use. Plugging of the donor's cannula by the wall of the vein being drawn against its end may be overcome by stopping the suction on the syringe and sliding the cannula slightly in or out. The syringes and cannulae may be carried, sterile, in an old tablet tin (obtained from advanced dépôt medical stores) with the partitions removed.

Illustrative Cases.

CASE I.

Severe lacerated shell wound of the left thigh, and fracture of the femur, admitted to dressing station with tourniquet and Thomas splint applied. Intravenous injection of one pint 5 per cent. gum and 4 per cent. sodium bicarbonate* produced a slight improvement in the pulse. The blood was tested, and found to belong to Group IV. A robust infantryman, buried by shell, offered some blood, but turned out to belong to Group II, and had to be rejected. A slightly wounded corporal, Group IV, volunteered, and a pint of his blood was transfused without difficulty by the syringe method. Some improvement was noted, and the patient was warmed up and sent on. He died just before reaching the casualty clearing station. We have since thought that if this case had been given more blood, and allowed to warm up longer in the dressing station, he might have survived the long ambulance journey.

CASE II.

Shell wound of the thigh and fracture of the femur brought into dressing station with legs tied together and considerable blood in the stretcher; morphine gr. $\frac{1}{2}$ had already been given. A tourniquet was at once applied and 1 oz. 50 per cent. ether in liquid paraffin given between mouthfuls of port wine (Gwathmey's oral analgesia). He was allowed to warm up for fifteen minutes; meanwhile his blood was found to belong to Group II. A Thomas splint was then applied without pain, the wounds packed, the tourniquet removed, and one pint gum solution given intravenously; he was wrapped up and allowed to remain on a heated stretcher. In less than an hour he was found to be in shock—extremely pale with bloodless conjunctivae and lead-blue lips, barely conscious, but the radial pulse still faintly perceptible. A donor (Group IV) with a sprained ankle was found and 800 c.cm. blood transfused. After the operation the patient's neck and face were definitely red and his cheeks warm to the touch. His mental state improved immediately, and he raised his head and smiled and talked to the dressers. After drinking some tea and café-au-lait, resting meanwhile on a heated stretcher, he was sent on to a casualty clearing station surrounded with hot-water bottles, where he

* Since the publication of Professor Bayliss's article we have changed our gum formula to 6 per cent. gum and 0.9 per cent. sodium chloride.

arrived, according to the officer on duty, "recovered from his shock and in excellent condition." It seems probable that if this case had been transfused immediately he would never have developed the shock which, untreated, would undoubtedly have meant his death before he reached the casualty clearing station.

Conclusion.

Although there has been opportunity to carry out the operation on a very few cases as yet, there is no doubt that blood transfusion by the syringe method can be done easily in an A.D.S., and, in the writer's opinion, could be done in an average regimental aid post; and by its use some cases of severe primary haemorrhage which would in the natural course of events die in the forward area will live to reach the casualty clearing station.

Indebtedness is especially acknowledged to Captain Cowell and to the teaching of the — Army R.A.M.C. school, as well as to Lieut.-Colonel T. J. F. Murphy, D.S.O., C.A.M.C., commanding the field ambulance.

AMOEBIIC ABSCESS OF THE LIVER.

BY

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AMOEBIIC abscesses of the liver are by no means uncommon in Mesopotamia, and are of interest for the manner in which the signs and symptoms frequently differ from those usually described in surgical textbooks. During the last twelve months over twenty cases have come under my observation in this hospital, besides many others already treated and passing through in various stages of convalescence during the course of evacuation from other hospitals.

As thousands of men have returned and will continue to return to England with active amoebae in the large intestine, I venture to record some of the principal features of the last twenty cases admitted to this hospital among British troops.

Signs and Symptoms.

Patients usually give a history of former attacks of diarrhoea or actual passage of blood and mucus, and *Entamoeba histolytica* can usually be found in the stools. The onset of the disease is usually insidious, loss of appetite, malaise or wasting causing the patient to report sick. In a few cases, however, the disease runs an acute course and the onset is surprisingly rapid. In one case in which one abscess was opened and four more found *post mortem*, the patient was apparently well and doing full duty until eight days before the operation; as death occurred ten days later, the whole illness lasted only eighteen days. In another patient, who had been some days in hospital under observation, the temperature was not above 99° until three days prior to a large abscess being opened.

Pain may be a marked symptom, indicating that the abscess is near the surface of the liver, and is sometimes a useful guide to its position. Referred pain in the right shoulder suggests subdiaphragmatic irritation of the phrenic nerve, whereas pain in the epigastrium or loins may indicate an abscess in the lower part of the liver.

Vomiting occasionally occurs, but jaundice is rare; a slight icteric tint, with a trace of bile in the urine only, was noticed in one case.

With an abscess of large size or long duration, cachexia and signs of septic absorption—oscillating temperature, sweats, rigors, furred tongue, etc.—are well marked, but an interesting feature is that the pulse-rate is often relatively slow in proportion to the temperature. (The chart shows the temperature in a typical case.)

The cytological examination of the blood is of great importance; the leucocytosis and an increase in the percentage of polymorphonuclear cells so characteristic of pus are usually well marked. The most striking blood picture in this series of twenty cases was a total white cell count of 43,000 per cubic millimetre (with 89.8 per cent. polymorphs), and the least striking showed 12,500 white cells (74 per cent. polymorphs). There seem to be no other constant blood changes, and eosinophils are not usually present in greater numbers than normally.

The x-ray screen is useful in diagnosis in doubtful cases, or to afford confirmation where a liver abscess is suspected. Three points are of assistance: first, increase in the size of the liver in an upward direction; secondly, limitation of movement of the diaphragm, the normal 1 in. to 1½ in. being reduced to ½ in. or ¾ in. even on deep inspiration; and thirdly, the normal dome-shaped diaphragmatic convexity may be distorted by a bulging representing a pointing abscess.

Course.

There is some clinical evidence to show that small abscesses may be absorbed, and this is especially probable in cases where the resistance of the tissues to amoebic invasion has been increased by emetine injections.

The usual course in Mesopotamia seems to be rapidly progressive, and sometimes surprisingly so, and is well illustrated in one case in which the patient had never left England prior to his embarkation for Mesopotamia, so that the possibility of previous amoebic infection is very remote. He had been in Mesopotamia less than a month when he was admitted and an abscess containing nearly a pint of pus evacuated from the liver, amoebae being found in the pus in the course of a few days.

In most cases the abscess apparently increases steadily in size and may rupture through the diaphragm or into the peritoneal cavity; this being a comparatively slow process, it is well shut off by adhesions among the neighbouring organs.

In one case liver abscess was diagnosed, and it was decided to operate on the following day, but the patient suddenly collapsed and died in a few minutes. *Post mortem* it was found that two large abscesses were present, one of which had ruptured into the inferior vena cava, death occurring from the resultant haemorrhage.

Diagnosis.

In well marked cases the diagnosis presents little difficulty—the enlargement of the liver, signs of toxæmia, blood picture and x-ray screen, all pointing to the correct diagnosis. It may be difficult to distinguish between a right-sided empyema and a liver abscess. The latter, if situated in the upper right lobe, may cause compression of the lung, with dullness and feeble breath sounds as high up as the angle of the scapula; also some fluid in the pleural sac may accompany a liver abscess, as in one case admitted as pleural effusion in which the liver abscess was discovered subsequently. In these cases the final appeal may be to the exploring needle, the diagnosis resting on the site of the discovered pus.

The increase in the percentage of polymorphonuclear cells in the blood is of much assistance in distinguishing between simple and suppurative inflammation of the liver. A good illustration of the value of the differential cytological examination was that of a patient admitted with an enlarged and painful liver, slight fever, and diarrhoea. His total white cell count was 18,500 per c.mm., but of these only 60 per cent. were polymorphonuclear. A diagnosis of dysenteric hepatitis was made, and the condition cleared up with dieting and hypodermic injections of emetine.

In two cases where the abscess was in the lower part of the right lobe and situated near the mid-line, the

CHART I.—E, Emetine, gr. 1; o, operation. Quinine, gr. 30, was given on June 7th and June 8th. Blood film examined for malaria on June 6th, and blood culture for enteric group on June 12th; both gave negative results. The patient was sent to the base on June 30th.