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MINISTRY OF HEALTH

NOTES ON TRANSFUSION FOR HOUSE OFFICERS.

Miss Taylor Room 1914 E. Tower

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NOTES ON TRANSFUSION FOR HOUSE OFFICERS

ISSUED BY THE MINISTRY OF HEALTH
FOR THE NATIONAL BLOOD TRANSFUSION SERVICE

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CONTENTS

BLOOD TRANSFUSION

Transfusion therapy should be undertaken only after careful assessment of the patient's clinical condition to determine the nature and quantity of fluid to be transfused, and the rate of administration. The patient may require whole blood, concentrated red cells, or plasma.

I. Choice of Fluid

1. WHOLE BLOOD is used to restore blood volume or the oxygen-carrying capacity of the blood, or to replace one or more missing elements of the blood. A standard bottle contains approximately 540 ml. citrated blood (approximately 420 ml. blood and 120 ml. anticoagulant solution, acid-citrate-dextrose).

Blood is commonly indicated for :—

(i) Haemorrhage—acute or chronic.
(ii) Anaemia—acute or chronic.
(iii) Oligaemic shock.
(iv) Blood deficiency states, e.g., haemophilia, haemorrhage of the newborn, hypoproteinaemia, etc.

2. CONCENTRATED RED CELLS are ideal for the treatment of anaemic states in which it is desired to raise the haemoglobin level, and in which blood volume restoration is not required. A bottle contains the cells from one or more bottles of whole blood, and should not be used more than 24 hours after preparation.

3. PLASMA OR SERUM (dried or fluid) should be reserved for the following conditions :—

(i) Burns and crush injury.
(ii) Hypoproteinaemia.
(iii) Traumatic shock or haemorrhage
(iv) Maternity cases.

} { *In emergencies when blood is not immediately available.*

A bottle of dried plasma or serum contains the dried solids from 400 ml. citrated plasma (serum). A bottle of fluid plasma contains approximately 500 ml. citrated plasma.

Plasma or serum may be given without regard to the blood group of the recipient.

Plasma or Serum should not be given unless the advantages to be gained by its transfusion outweigh the risk of transmitting homologous serum jaundice (see Section VII (7)).

II. Storage of Blood and Plasma and Criteria of Fitness for use

1. BLOOD

(i) Blood should not be used unless there is a clear line of demarcation between the sedimented cells and supernatant plasma, which should be of a golden yellow colour and free from visible signs of haemolysis. Haemolysis is shown by a red discoloration, first seen in the plasma immediately above the cell layer, which gradually spreads upwards. Fat may collect as a white layer in some bottles : this is not a contra-indication to the use of the blood.

(ii) Time-expired blood must not be used.

(iii) *Storage of blood.* Refrigerators selected for use as blood banks must be kept under constant supervision by a responsible medical officer.

The correct temperature for blood storage is +4° C. to +6° C. These limits must be rigidly observed. Ideally, the refrigerator should have an automatic temperature recording device ; otherwise a maximum and minimum thermometer should be provided and the temperature recorded morning and evening in a book. Blood must never be allowed to freeze.

An accurate record of issues of blood, showing date and time of removal from the refrigerator, name of patient to whom it was given, and the name of the medical officer giving the transfusion, must be kept.

Blood which has been removed from the refrigerator for more than 30 minutes, and not used, or blood which has been only partly used, should be plainly marked as DANGEROUS FOR PATIENTS.

Time-expired blood and blood unfit for use should be segregated from blood which may be used for transfusion. It should be returned to the Regional Transfusion Centre and not allowed to accumulate.

Concentrated red cells should be used within 24 hours of preparation.

The blood bank refrigerator should not be used for the storage of food, e.g., meat, fish, vegetable, etc., or for storage of pathological samples.

2. FLUID PLASMA

(i) Fluid plasma should not be used unless it is crystal clear. Cloudiness or deposits may be caused by bacterial contamination and plasma showing these changes should be returned to the Regional Transfusion Centre.

(ii) *Storage* : Fluid plasma should be stored in a cool dark place. Refrigeration is not necessary.

3. DRIED PLASMA OR SERUM

(i) *Reconstitution of dried plasma or serum.* Each bottle is issued with a bottle containing 400 ml. non-pyrogenic sterile distilled water. Unscrew the caps of the bottle containing the water and the bottle of dried plasma/serum. If possible, flame the tops of the bottles and pour the water into the bottle of dried plasma/serum and replace the cap at once. Solution is helped by shaking, and should be complete in 4-5 minutes. An opaque solution results, due to lipoids in fine suspension. Dried plasma/serum is bottled in dry nitrogen and hermetically sealed. If the seal is damaged, moisture may gain access to the plasma/serum and cause denaturation of the proteins, which reduces their solubility. If, after adding water, complete solution is delayed beyond 5-10 minutes, or if a gel forms, the bottle should not be used.

Reconstituted plasma or serum must be used without delay. If not used within 3 hours it should be discarded.

(ii) *Storage* : Dried plasma or serum should be stored in a cool dark place. Refrigeration is not necessary.

III. Volume and Rate of Transfusion

Directions cannot be given dogmatically concerning the rate and volume of transfusion. The following factors must be considered—the age of the patient, the general condition, the state of the circulatory system, and the indication for the transfusion. The young adult, with a normal myocardium, will tolerate the rapid infusion of relatively large quantities of protein fluid, even when the blood volume is normal. The anaemic patient with an enfeebled myocardium, or those with respiratory or cardiac disorders, or infective and toxic conditions, on the other hand, must be transfused very cautiously.

(1) In the presence of severe injury or acute blood loss, the rapid and adequate restoration of the blood volume is the immediate aim, and sufficient blood (or where sufficient blood is not available, plasma and blood in ratio 1 : 2), to raise the blood pressure to at least 100 mm. Hg. should be given. *In the previously healthy* patient, a rate of 100 ml./minute will usually be tolerated until the B.P. reaches 100 mm. Hg. Thereafter the rate must be slowed, and the transfusion continued cautiously at a drip rate. Generally speaking, in the treatment of oligaemic shock only sufficient blood or plasma should be transfused to restore and maintain the systolic blood pressure at its normal level. Therefore, the blood

pressure should be recorded regularly throughout transfusion and certainly at least after each bottle transfused. For practical purposes, the reliable guide to the quantity of fluid to transfuse is the patient's systolic blood pressure.

(2) In treating anaemia, it may be assumed that one standard bottle of whole blood will raise the haemoglobin some 7 per cent, and one standard bottle of concentrated red cells (the cells from two bottles of whole blood) will raise the haemoglobin some 15 per cent. If the volume of whole blood required to raise the haemoglobin to the chosen level exceeds one third of the calculated blood volume (40 ml./lb./body weight), the transfusion should be given in two parts, separated by two days.

The rate of administration should not exceed 20-40 drops per minute, and in *anaemias* with haemoglobin less than 25 per cent, *cachexia, cardiac or respiratory disease*, this rate should be halved. The chosen rate of flow should be constantly and accurately maintained, and watch kept for cardiac embarrassment. (The venous pressure is a most valuable sign, and should be closely observed.) Similar caution must be used in transfusing *septic* and *toxic patients*. A large volume of fluid, even slowly over a long period, should not be given to patients with these conditions : it should be divided and given slowly as a number of small transfusions.

Ideally, no major surgical procedure should be carried out unless the haemoglobin is within normal limits. Pre-operative transfusions for anaemia should be given an adequate time before operation to allow the full benefit of the transfusion to develop and to avoid the possibility of a reaction during operation.

IV. Blood Grouping and Direct Matching

Before a blood transfusion is started the recipient's ABO and Rh blood groups should be determined, a bottle of homologous blood selected and a careful direct matching test carried out. **Indiscriminate use of Group O blood is undesirable and may be dangerous.**

There is no laboratory procedure in which the results of erroneous technique or interpretation are more disastrous than in the typing and direct-matching of blood. The result of a mistake may be fatal. For this reason it is desirable that these procedures be in the hands of an experienced individual. The printed directions for carrying out these procedures are deceptively simple and give a false sense of security.

1. Blood Samples

(i) *Adults and Children*. The ideal sample for blood grouping or direct-matching is not less than 2 ml. of blood collected with

a freshly boiled or, preferably, dry sterile syringe, and put into a dry sterile tube. Syringes kept in spirit or other antiseptic should not be used, since sterilization may be imperfect and haemolysis may be caused by traces of antiseptic solutions. After clotting the serum can be pipetted off into a separate tube. A cell suspension is then prepared by adding two drops of sedimented cells from the bottom of the tube after removal of the serum, to 2 ml. of normal (0.9 per cent) saline. A suspension of cells can be made in a similar manner from blood collected in dried oxalated tubes prepared according to Wintrobe's formula.

If the grouping test is to be done immediately, and it is not necessary to test the agglutinin content of the serum a suspension of cells may be made by adding 2 drops of blood obtained from the finger to 2 ml. of 1.5 per cent sodium citrate in normal saline. The blood may be taken by skin puncture.

(ii) *Infants.* In infants at least 10-20 drops of blood, from a stab wound in the heel made with a large needle, should be collected into 2 ml. of a solution of 1.5 per cent sodium citrate in normal saline, if the sample is going to be used for the determination of the blood group only. If the sample is to be used for direct-matching, 20 drops of blood should be collected into a dry tube.

Samples for direct-matching should be collected into dry tubes, since the serum is needed for this test.

2. THE LANDSTEINER (ABO) BLOOD GROUPS : The constitution of the ABO groups is :—

Blood Group	Agglutinogen Content of Cells	Isoagglutinins Present in Serum
AB	AB	None, i.e., neither anti-A nor anti-B
A	A	Anti-B
B	B	Anti-A
O	O (i.e., neither A nor B)	Anti-A and anti-B

Group A occurs approximately as frequently as Group O; it is therefore wasteful to use Group O blood irrespective of the recipient's blood group.

3. ABO BLOOD GROUPING TECHNIQUE. Ideally, grouping tests should be performed in tubes, since tests performed on slides, or on a tile, by inexperienced workers, may be attended by a rate of

error as much as 5 per cent. Technical details can be given only briefly here. For complete information see " Determination of Blood Groups," M.R.C. War Memorandum No. 9, 1943.

(i) *Tube Method.* Tubes, $2'' \times \frac{1}{4}''$, are suitable for the tube technique. Two tubes are required; label the first " anti-B " and the second " anti-A." Deliver with a Pasteur pipette, into each tube, one drop of normal saline. Next, to each tube add two drops of the suspension of " unknown " cells. The tube labelled " anti-B " then receives two drops of anti-B serum, and the tube labelled " anti-A " receives two drops of anti-A serum. Wash the pipette three times thoroughly in saline or tap water between each operation. Shake the tubes thoroughly and allow them to stand for two hours. Alternatively, after allowing the tubes to stand for 5 minutes centrifuge at 500-1000 revs./min. for one minute. Readings are made by flicking the tube sharply with the right index finger, the tube being held between the left thumb and forefinger. If the reaction is positive agglutinated cells rise in a solid clump or clumps. If the reaction is negative sedimented cells swirl up into a uniform suspension. In doubtful cases, a drop of fluid from each tube should be examined, for evidence of agglutination, under the microscope. If agglutination occurs in neither tube the unknown blood is Group O. If agglutination occurs in the tube marked " anti-A" but not in the tube marked " anti-B," the unknown blood is Group A. If agglutination occurs in the tube marked " anti-B," but not in the tube marked " anti-A," the unknown blood is Group B. If agglutination occurs in both the tube marked " anti-A" and that marked " anti-B," the unknown blood is Group AB. The agglutinin content of the serum of the unknown blood should also be tested when possible against standard A and B cells, to exclude false positive and negative reactions, e.g., a group O serum will agglutinate both A and B cells.

(ii) *Tile Method.* Blood grouping may be rapidly performed on glass slides or on a tile, though the test is not absolutely reliable in the hands of the inexperienced worker. The same reagents are required as above. Mark one slide " anti-B " and place on it a large drop of anti-B typing serum. Another slide marked " anti-A" receives a drop of anti-A typing serum. To each drop of typing serum add two drops of the suspension of unknown red cells, prepared as already described. Mix the typing sera and cell suspension thoroughly with the aid of a glass rod or platinum wire. Do not transfer the slightest trace of one mixture to the other. Rock the slides gently and read the results after five and not later than fifteen minutes. Do not perform the test by mixing a drop of undiluted whole blood with the serum.

The following table shows the reactions of blood of the four Landsteiner groups, with anti-A and anti-B sera :—

Blood Group of Cells	Blood Typing Serum	
	Anti-A	Anti-B
AB	+	+
A	+	—
B	—	+
O	—	—

(+ = agglutination. — = no agglutination).

(iii) *Sources of error* in blood grouping cannot here be considered in detail, but the following points are important.

Store fluid typing sera FROZEN SOLID (−20° C). Dried typing sera may, however, be kept at room temperature.

Typing sera must be of high titre and may be obtained from the Regional Transfusion Centres, which distribute sera prepared by the Blood Group Reference Laboratory, Ministry of Health, Lister Institute, London, S.W.1.

Tests should, preferably, be performed on fresh blood samples. Infected sera or blood samples may give rise to false positive or false negative reactions.

Perform tests in a warm room, so as to avoid false positive reactions due to cold agglutination.

Control tests with known A, B and O cells should be put up.

4. Rh BLOOD GROUPING : The Rh group of every person who is to receive a transfusion should be determined (see Section IX). These tests should be performed only by experienced workers. If in doubt of the procedure to be followed in a particular case the hospital pathologist should be consulted.

5. DIRECT MATCHING TESTS : Every blood transfusion, where a short delay will not jeopardize life, should be preceded by a direct matching test, the data of which must be recorded. This test should be performed as soon as possible before the transfusion is given. The onus of ensuring that it is done should rest with the clinician who is to give the transfusion.

The direct matching test should be carried out only by an experienced worker.

The test involves matching the recipient's serum against the donor's cells. A fresh sample of the recipient's serum should be obtained before each transfusion. The technique of direct matching

is essentially that of blood grouping. The tube test, which will detect the presence of complete Rh antibodies, should be used in preference to the tile technique. The tubes should be incubated at 37° C for two hours, the sediment gently removed with a Pasteur pipette, lightly drawn across a glass slide, so that agglutinates, if present, are not broken up, and examined microscopically.

The tube test will not detect incomplete Rh antibodies. For this purpose special techniques must be used (see M.R.C. Memorandum on Rhesus Factor, No. 19, 1948) which should only be performed by more experienced workers. The Regional Transfusion Centre will, if required, undertake these tests or give instruction.

If, for any reason, a direct matching test is not performed, 2-3 ml. of blood should be withdrawn immediately before giving the transfusion. Blood samples used for direct matching or pre-transfusion samples should be kept in the refrigerator (+4° C to +6° C) for 3 days after the transfusion since they may be required for investigating reactions.

Rigorous asepsis must be maintained if bottles of blood are opened to obtain a sample of the donor's blood.

Direct matching tests in transfusions of concentrated red cells must be performed between the recipient's serum and the cells of the individual bottles of blood, before the cells are pooled.

V. Administration of Transfusions

Practical instruction is essential. The following points are important :—

(1) Never fail to re-examine the bottle label before beginning transfusion. Incompatible transfusion disasters have occurred through neglect of this simple precaution.

(2) Do not heat blood or plasma before use. It is safe to transfuse blood cold from the refrigerator, except under special circumstances, e.g., exsanguination transfusions in infants.

(3) Do not leave blood out of the refrigerator for longer than 30 minutes. After that time it must then be considered **Dangerous for Patients,** so labelled, and put back into the refrigerator.

(4) Do not reconstitute dried plasma until just before use.

(5) Most transfusions can be given by simple venepuncture. Select a vein in the forearm in preference to one in the antecubital fossa, especially with a restless patient, or during transport of a patient, since a needle in the antecubital fossa may be dislodged or driven through the vein, even when splinting is apparently

secure, and precludes flexion of the elbow to the great discomfort of the patient.

(6) Do not cut down on a vein for it is seldom justifiable. If cannulation is unavoidable, a vein in the leg rather than one in the arm should be used. The internal saphenous vein is the most convenient. It is found one or two inches proximal to, and slightly lateral to, the internal malleolus, on the subcutaneous surface of the tibia near the anterior border. *Never cut down on a vein in the antecubital fossa.*

(7) Apply a tourniquet or a sphygmomanometer cuff (50-60 mm. Hg.) round the upper part of the limb to distend the veins.

(8) Employ palpation as well as inspection in selecting a vein. After sterilizing the skin, inject a little local anaesthetic (0.25 ml.) intradermally over the selected vein.

(9) Connect the transfusion apparatus with the bottle and see that it is in working order before the transfusion. First the clip should be tightly clamped on the distal length of rubber tubing a few inches from the needle mount, and the rubber bung inserted in the bottle. The bottle should then be suspended at a height of 3-4 feet above the site of venepuncture. Let the rubber tubing, etc., hang full length; then hold the distal length of rubber tubing up in a U so that the distal end does not come above the level of the drip counter. This procedure is important if "flooding" of the drip counter is to be avoided. Slowly open the clip and allow the blood to expel all the air from the distal tubing.

To avoid spilling blood through the air-inlet tube when the bottle is inverted to be suspended, a small sterile cork (provided in the set) is inserted in this tube. The cork must be removed after the bottle is suspended, otherwise the blood will not flow when the screw clip is released.

(10) Introduce the needle into the vein, release the tourniquet and fix the needle and rubber tubing securely in position with adhesive strapping in such a way that no pull is exerted on the needle.

(11) See that the patient is comfortable and that the arm or leg is suitably placed on a pillow if necessary. Splinting may be advisable, and is usually necessary if the patient is to be moved, or is restless or unco-operative.

(12) When the transfusion is completed, return the unwashed bottle to the refrigerator for 36 hours. WASH THE SET IMMEDIATELY by flushing through with cold tap water from another transfusion bottle.

VI. Transfusion Records

1. A record of every transfusion should be made, preferably in the patient's case notes AND on the special card or form (N.B.T.S. 11) attached to the bottle.

Such records should show :—

(i) *Serial numbers of bottles of blood and plasma.* The recording of these numbers must never be omitted, since they may be the only means of tracing and checking a donor's blood if there is any question of incompatible transfusion, or homologous serum jaundice. The latter occurs 40-120 days after transfusion of plasma or serum or, rarely, of blood, and it is not only important to be able to trace the donor bearing the infective agent, but also to be able to trace and withdraw other bottles of the same icterogenic batches of plasma or serum. Only by the careful and invariable recording of serial numbers on bottles of transfusion fluid can this be accomplished. All cases of homologous serum jaundice should be reported immediately to the Regional Transfusion Officer. The necessity of accurate recording is not yet fully appreciated.

(ii) In transfusions for anaemia : the pulse rate recorded half-hourly, and the temperature recorded hourly, throughout transfusion and for four hours afterwards.

(iii) In transfusions for oligaemic shock : the pulse rate and blood pressure recorded after each bottle of fluid transfused.

(iv) The time taken to give the transfusion.

(v) Results of urine analysis. As a routine, the urine voided before every transfusion and any urine voided during the transfusion and in the twenty-four hours afterwards should be tested (colour, albumin test and examination of sediment). The reason for this is that the donor's blood may be abnormally rapidly destroyed and haemoglobinuria may occur, perhaps only once, and may be the sole evidence of this destruction. It is therefore important to examine all urine voided during and after transfusion.

(vi) Particulars of any immediate reactions to transfusion (for classification see below under Complications and Dangers of Transfusion).

2. Every hospital should keep a record book showing the following details of all transfusions of blood and plasma. Whenever possible the

hospital transfusion officer should keep this record; in hospitals having no transfusion officer it should be the duty of a responsible person.

The book should show :—

(i) Date of transfusion.
(ii) Full name of recipient.
(iii) Blood group (ABO and Rh) of recipient.
(iv) By whom direct-matching test was performed.
(v) The serial number and blood group (ABO and Rh) of each bottle of blood transfused.
(vi) The serial number of each bottle of plasma or serum transfused.
(vii) Clinical condition necessitating transfusion.
(viii) Reactions, stating—
  (*a*) their nature;
  (*b*) whether patient had a history of miscarriage, still birth, hydropic jaundiced babies, or has had previous transfusions, or injections of blood or plasma.
(ix) Signature of doctor giving the transfusion.

VII. Complications and Dangers of Transfusion

1. Febrile Reactions

Classification. Grade 1. Rise of temperature to 100° F;
Grade 2. Rise of temperature above 100° F with sensation of chill, but no actual shivering;
Grade 3. Rigor—with or without other symptoms.

The significance of a febrile reaction depends upon the cause. Generally a grade 3 reaction during transfusion is an indication for stopping the transfusion.

2. Circulatory Overloading and Pulmonary Oedema. The danger of circulatory overloading exists in heart disease, chronic anaemia and cachectic states, severe sepsis, toxaemia, etc., in babies and aged persons. The risk will obtain if transfusion is too rapid, or if the quantity of fluid transfused is too great for the particular case. Circulatory overloading can be avoided by slow drip transfusion and avoidance of transfusion of excessive quantities. The ideal material for severe anaemic states is concentrated red cells.

3. Incompatible Transfusion. This disaster is avoided by transfusing strictly homologous blood, i.e., blood of the same ABO and Rh groups as those of the recipient, which has been subjected

to a direct matching test. Group O blood should not be used indiscriminately since the isoagglutinins of certain O donors are exceptionally potent and may cause destruction of the red cells of an AB, A, or B recipient.

Symptoms of incompatible transfusion vary from case to case. Usually there is a rapidly developing febrile reaction, sometimes after as little as 200 ml. of blood have been given, accompanied by dyspnoea, intense headache, a feeling of constriction of the chest, and pain, sometimes intense, in the lumbar region. The reaction usually occurs during or immediately after transfusion, but signs and symptoms may not appear for some hours. None may be apparent in the unconscious patient. Haemoglobinuria and jaundice may occur. Several hours will usually elapse before the onset of jaundice and it may be delayed for several days. Haemoglobinuria is usually transient. Suppression of urine is the usual cause of death.

Treatment. The transfusion should be stopped immediately an incompatibility is suspected and expert advice should be obtained. Meanwhile, the following treatment may be instituted to promote diuresis and an alkaline urine. (The quantities are suitable for the average adult, weighing 10 stones, and should, if necessary, be adjusted.)

(i) Give initially 120 ml. 3 per cent tri-sodium citrate intravenously.

(ii) If fluids can be taken by mouth, one pint of water should be given, followed by a further pint hourly for four hours. If the reaction of the urine is acid or neutral give by mouth sodium citrate gr. 40, suitably dispensed, two or four hourly until the reaction of the urine is alkaline.

(iii) If fluids cannot be taken by mouth, 1 litre of 5 per cent glucose in distilled water to which 120 ml. of 3 per cent tri-sodium citrate have been added should be administered intravenously at a rate of 40 drops/minute.

A fluid balance chart should be kept.

It may be noted here that transfusion of effete or haemolysed blood, e.g., out-dated or infected blood, or blood which has been frozen or over-heated, may cause a haemolytic reaction, the effects of which are similar to those of an incompatible transfusion.

4. EMBOLISM. Transfusion apparatus should be carefully examined for faults or leaks, since these may be a source of air embolism. Continuous supervision must be exercised by a doctor if a Higginson's syringe is used to apply positive pressure to the transfusion bottle. Positive pressure must NEVER be applied after the bottle is three-quarters empty. Air embolism has followed faulty cannulation of a vein. Fatal embolism, due to multiple particles

of fibrin, has been reported and, therefore, fluid plasma should not be used if multiple small particles are present.

5. ALLERGIC REACTIONS. Skin rashes, urticarial weals and angioneurotic oedema may complicate transfusion. Treatment is with adrenaline, anti-histamine products, etc., and de-sensitisation may be necessary.

6. TRANSMISSION OF INFECTION. Never leave blood out of cold storage longer than thirty minutes. Breaks in refrigeration may allow chance contaminating bacteria to multiply and such blood may cause a severe or even fatal reaction. Wear a mask when uncapping the transfusion bottle. Blood issued by Regional Transfusion Centres to banks is tested for syphilis. When blood is taken from a donor and transfused immediately, i.e., fresh, as opposed to stored blood, it is the *responsibility of the physician* to ensure that the donor is free from syphilis, or other transmissible disease.

7. HOMOLOGOUS SERUM JAUNDICE. This complication appears 40 to 120 days in up to 10 per cent of persons receiving transfusions of "large pool" plasma and in 2-3 per cent of persons receiving "small pool" plasma, and should be reported immediately to the Regional Transfusion Officer. The jaundice is due to hepatitis thought to be caused by a virus, and may be fatal. *Plasma should not, therefore, be used unless the benefits to be gained by the transfusion outweigh the risk of transmitting homologous serum jaundice.* This complication may very occasionally follow the transfusion of whole blood.

VIII. Investigation of Transfusion Reactions

In the event of a severe reaction occurring, the Regional Transfusion Officer should be notified. The following specimens are needed, initially, to make an investigation :—

(1) The blood samples used for the direct matching test before transfusion or the pre-transfusion sample (see Direct Matching Tests). Such samples should be kept for three days in the refrigerator.

(2) The remains of blood or plasma in the bottle, or bottles, used for transfusion. (All bottles of blood or plasma used for transfusion should be kept in the refrigerator (+4° to +6° C) for 36 hours after use, lest investigations prove necessary. After the elapse of this time they should be washed.)

(3) A 10-20 ml. sample of blood from the patient collected, in a freshly boiled or dry sterile syringe, one hour after

the end of the transfusion. Put about 2 ml. into an oxalated tube and the remainder into a dry sterile tube.

(4) A clean sample of urine. All urine voided for two or three days should be measured and examined ; abnormally coloured urine should be conserved for investigation.

Most haemolytic reactions are accompanied by haemoglobinaemia or hyperbilirubinaemia, or both, but these phenomena will depend upon the rate of destruction and elimination of the transfused blood, upon the rate at which the blood is given, and when the sample is taken. Examination of a sample of blood for these features is often the quickest way to decide whether a reaction is or is not haemolytic.

IX. The Rh Factor

The Rh group of a recipient should always be determined except in emergencies when there is not time. About 50 per cent of Rh-negative recipients, irrespective of their sex, may become immunised to the Rh factor if given transfusions of Rh-positive blood. A proportion of Rh-negative mothers may become immunised to the Rh factor during pregnancy by bearing Rh-positive foetuses, the latter inheriting the Rh factor from the father. Any of these immunised persons will, if transfused with Rh-positive blood, respond by destroying the donor's blood. A fatal haemolytic reaction may occur. Moreover, a single transfusion may so sensitize a female to the Rh antigen that any subsequent Rh-positive offspring may be affected with haemolytic disease in the severest forms.

Females who have borne or who may bear children should be transfused only with Rh compatible blood, except in emergencies in which there is not time to determine the Rh group. In such cases Rh-negative blood should be given and, if this is not available, plasma or serum may be used.

In first transfusions in males and nulliparous females past the menopause, the Rh group can be ignored in dire emergencies, but the pre-transfusion sample should be submitted for Rh grouping without delay. Otherwise, however, all transfusions should be Rh compatible and an Rh compatibility test should never be omitted in second and subsequent transfusions.

Infants suffering from erythroblastosis foetalis (haemolytic disease of the new born), due to rhesus-immunisation of an Rh-negative mother, should be transfused with Rh-negative

blood, though the infant itself is Rh-positive. (For a full consideration of the Rhesus Factor see M.R.C. Memorandum No. 19, 1948).

N.B.—Since only 15-16 per cent of donors are Rh-negative, and only 6-7 per cent. are group O Rh-negative, the transfusion of Rh-negative blood to Rh-positive recipients must be avoided. Rh typing should, if possible, always be done, so that Rh-negative blood is not used unnecessarily.

X. The Regional Transfusion Centre

The Regional Transfusion Centre will supply :—

Whole Blood; Concentrated Red Cells; Glucose-citrate solution for the collection of blood.

Dried plasma; Sterile pyrogen-free distilled water for the reconstitution of dried plasma.

Grouping Sera; Transfusion apparatus.

It will undertake, on request, the investigation of haemolytic or other types of reactions, and will advise on problems relating to transfusion.

Routine investigations performed by the Regional Transfusion Centre include the blood grouping of donors and recipients, Rh investigations in relation to pregnancy including the Rh-typing of pregnant women, serological tests for the detection of haemolytic disease of the new born, Rh-genotyping in special cases, investigation of irregular isoagglutinins, and direct-matching and special compatibility tests.

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