Notes on Transfusion

Revised 1973

Notes on Transfusion

Issued by the Department of Health and Social Security with the Scottish Home and Health Department and Welsh Office

for the

National Blood Transfusion Service and the Scottish Blood Transfusion Association

1973

CONTENTS

This edition of "Notes on Transfusion", like the four previous editions, has been prepared by the Committee of Regional Transfusion Directors of the Department of Health and Social Security and Welsh Office. The booklet is intended primarily for use by medical staff of hospitals and its purpose is to describe briefly some of the principles of the practice of transfusion and to suggest procedures; it is not intended that the booklet should supersede already established local practice and procedures without the agreement of those concerned. These notes are not exhaustive or exclusive, for the subject is too large for all methods and procedures in use to be described.

NOTES ON 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 other blood components or one of the special plasma fractions. The nature and quantity of fluid transfused and the rate of administration are determined by initial clinical examination and subsequent response to therapy.

A transfusion should never be given without a definite indication; not only is this in the patient's interest, since an element of risk is associated with every transfusion, but supplies of blood are not unlimited and with the ever-growing demand for blood it is imperative that it should not be used unnecessarily.

The use of transfusion to correct moderate or slight degrees of anaemia that could be overcome as effectively, if more slowly, by other means, seems unjustifiable unless some cogent reason for speed of recovery exists. In some instances failure to institute simpler and safer but equally effective treatment earlier leads to the quite unnecessary use of blood transfusion.

I Choice of Fluid

1. WHOLE BLOOD is used to restore blood volume. Its use where concentrated red cells are more suitable is not good transfusion practice. It is supplied either in a British Standard transfusion bottle containing approximately 540 ml citrated blood (approximately 420 ml blood and 120 ml acid citrate-dextrose anticoagulant solution) or in a plastic bag containing about 495 ml citrated blood (about 420 ml of blood and 75 ml acid citrate-dextrose anticoagulant solution).

Blood is sometimes indicated for:

(i) Haemorrhage
(ii) Oligaemic shock
(iii) Certain forms of anaemia (see below)
(iv) Haemolytic disease of the newborn

(See Risk of Serum Hepatitis, Section VII 9)

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 needed. Concentrated red cells should be used as soon as possible and in any case not more than 12 hours after preparation unless separation has been effected by a 'closed' system, for example with certain plastic bags, when an expiry date will be indicated on the bag. In certain rare cases where patients react to compatible whole blood (for example sensitivity to plasma) washed red cells may be required but such rare cases should be discussed with the hospital pathologist. (See Section VII 9)

3. PLATELET TRANSFUSION. Platelet transfusion may be indicated in patients with bleeding due to severe thrombocytopenia. If the patient requires red cells and plasma as well as platelets, fresh whole blood should be transfused. If red cells are not required it is best to transfuse platelet rich plasma or platelet concentrate.

About 80% of the total platelets of a donation will be present in platelet rich plasma and about 50% in platelet concentrate. Platelet function in these preparations is probably reduced. All platelet preparations should be transfused as soon as possible and their supply should be discussed with the hospital pathologist. (See Section VII 9).

4. WHITE CELLS. It has not yet proved possible to transfuse white cells successfully.

5. DRIED POOLED PLASMA. This is shortly to be replaced by Plasma Protein Fraction (PPF) and either can be used for the conditions shown below. A bottle of dried plasma contains the dried solids from 400 ml citrated plasma. Pooled plasma may be given without regard to the blood group of the recipient. (See Section VII 9).

6. PLASMA PROTEIN FRACTION (Human Albumin Fraction Saline) is used in the following conditions:

(i) Burns and crush injury

(ii) Oligaemic shock due to haemorrhage. Plasma protein fraction may be used in cases of blood loss in childbirth and during operation, gastro-intestinal haemorrhage or any other form of acute blood loss until compatible blood is available.

It is supplied as a 4·5 g per cent protein solution in bottles, each containing 400 ml. This solution exerts approximately the same colloid osmotic pressure as an equal volume of reconstituted freeze-dried small pool plasma. Not less than 90 per cent of the protein has the electrophoretic mobility of albumin, the remainder of the protein being α and β globulins. The solution, stabilized with sodium caprylate, is heated to 60°C for 10 hours to inactivate the causative agent of serum hepatitis. The solution contains 130–160 millimoles Na per litre and not more than 0·2 millimoles K per litre. It does not contain fibrinogen or pseudocholinesterase.

Plasma protein fraction may be given without regard to the blood group of the recipient.

Plasma protein fraction will gradually replace reconstituted dried human plasma and, since it is a more economical material to prepare than albumin should, whenever possible, be used in preference, unless there are specific indications to use albumin.

7. HUMAN ALBUMIN may be used for the same conditions as Plasma Protein Fraction. It is also used particularly in the following conditions:

(i) In certain disorders of the liver, for example cirrhosis in which hypoalbuminaemia occurs. Its value is uncertain although benefit to patients with predominantly peripheral oedema has been reported.

(ii) It has also been used in nephrotic nephritis with the purpose of inducing diuresis. Its value has not been established.

A bottle of freeze dried albumin contains approximately 25 g protein of which not less than 95 per cent has the electrophoretic mobility of albumin. Before freeze-drying, the solution, stabilized with sodium caprylate, is heated to 60°C for 10 hours to inactivate the causative agent of serum hepatitis. 100 ml 25 g per cent solution is osmotically equivalent to 500 ml plasma. Compared with plasma protein fraction, human albumin contains less sodium chloride (Na not more than 65 millimoles/g protein) and less potassium (not more than 0·05 millimoles/g protein). It does not contain fibrinogen or pseudocholinesterase.

The use of concentrated albumin solution enables relatively large amounts of protein to be given in a small volume of fluid but haemodilution occurs rapidly. In these circumstances care must therefore be exercised if any cardiac disorder is present; if the patient is dehydrated, additional fluid should be given.

Albumin may be given without regard to the blood group of the recipient.

8. FRESH FROZEN PLASMA (F.F.P.). This is ACD plasma which has been separated from the red cells immediately after collection and kept frozen, preferably at −25°C or lower. Clotting factors V, VIII and IX are satisfactorily preserved for several months at these temperatures. It is used in the management of certain disorders of coagulation, particularly haemophilia (Factor VIII deficiency). Plasma from a donor of the same ABO and often the same Rh (D) group is normally given (See Sections VII 2 and VII 9).

9. CRYOPRECIPITATE AND DRIED ANTIHAEMOPHILIC GLOBULIN CONCENTRATE. Both these preparations have a high concentration of antihaemophilic globulin and are specifically used in the treatment of haemophilia. The concentration of antihaemophilic globulin in cryoprecipitate may vary widely. Dried antihaemophilic globulin, unlike cryoprecipitate, can be prepared in a manner which allows the potency of each batch to be assayed. The quantities of concentrate available are at present relatively limited. Both cryoprecipitate and concentrate are normally issued to special centres for the treatment of haemophilia. Cryoprecipitate is not of use in Factor IX deficiency (Christmas disease) or Factor V deficiency. Factor IX deficiency may be treated with fresh frozen plasma, but severe degrees of deficiency will require treatment with a concentrate of Factor IX (see below). Factor V deficiency may also be treated with fresh frozen plasma. (See Section VII 9).

10. DRIED FACTOR IX CONCENTRATE. This preparation contains Factor IX, prothrombin and Factor X, each usually concentrated to approximately the same degree. According to the method of preparation Factor VII may or may not also be present. The potency varies with the method of preparation; the amount in each bottle also varies but will be stated on the label. Some preparations contain heparin. (See Section VII 9).

11. FIBRINOGEN is indicated to control haemorrhage in the defibrination syndrome, for example in some cases of obstetrical accidental haemorrhage or after cardiac surgery, when the fibrinogen concentration in the plasma has fallen to 100 mg per 100 ml or lower. The fibrinogen level should be determined whenever possible before transfusion of fibrinogen. Each bottle of dried fibrinogen contains between about 1·5 g and 2·0 g. The amount is stated on the label. Dried fibrinogen is reconstituted with 200 ml sterile pyrogen-free distilled water. (See Section VII 9).

12. PLASMA SUBSTITUTES are solutions of macromolecular substances which possess properties (for example viscosity and colloid osmotic pressure) resembling those of plasma and are not toxic or antigenic. They do not contain haemoglobin, protein (except in gelatin solutions), antibodies or clotting factors and have only slight buffering effects. They may be given to recipients of any blood group. *Plasma substitutes may interfere with compatibility tests: a specimen of blood for such tests should, therefore, always be collected before giving a plasma substitute. If a compatibility test is needed and a plasma substitute has already been given, the laboratory should be informed of this.* Febrile and other forms of reaction may rarely attend the use of plasma substitutes. Plasma substitutes are not substitutes for whole blood nor are

they complete substitutes for plasma or plasma protein fraction. They should therefore be used with discretion. Their main use is the restoration of a depleted blood volume when supplies of blood, plasma or plasma protein fraction are lacking or inadequate.

Plasma substitutes (pooled plasma or plasma protein fraction) should not be given in such quantities that the haemoglobin concentration is depressed below 9·0 g per cent (62 per cent); in any case the haemoglobin concentration should not be allowed to fall below 7·0 g per cent (47 per cent) for more than a short time.

The useful plasma expanders for emergency treatment of haemorrhage while awaiting crossmatched blood are Dextran 110 and Dextran 70. Dextran 40 is rapidly excreted and is relatively unsuitable as an expander.

Dextran has been reported to cause a prolongation of the bleeding time and it is therefore probably wise not to give it, or to give a limited amount (i.e. up to 1 litre in an adult), if the clotting mechanism is abnormal.

13. LEUCOCYTE-POOR BLOOD prepared by, for example, removal of the buffy layer or by dextran sedimentation may be necessary in a case with white cell antibodies which has shown adverse reactions to whole blood. Such a case should be discussed with the hospital pathologist (See Section VII 1). Leucocyte-poor blood is also used in an attempt to prevent the formation of cytotoxic antibodies in patients awaiting organ transplantation. (See Section VII 9).

II Storage of Blood, Plasma and Plasma Fractions and Criteria of Fitness for Use

1. BLOOD

(i) A container of blood should not be issued unless there is a clear line of demarcation between the sedimented cells and the supernatant plasma which should be straw coloured and free from visible signs of haemolysis. Haemolysis may be shown by a reddish purple discolouration in the plasma immediately above the cell layer, which gradually spreads upwards. Fat may collect as a white layer on the surface of the plasma in some bottles but this is not a contraindication to the use of the blood. Inspection of the plasma in plastic bags is difficult unless they are stored upright.

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

(iii) Storage: Blood should be stored only in a special blood bank refrigerator which has been specifically designed for the purpose and satisfies British Standard Specification No. 4376 (1968) and must be under constant supervision by a responsible member of the medical staff. Normally the hospital pathologist is in charge of the blood bank and is responsible for the constant supervision of the refrigeration.

The blood bank refrigerator should not be used for the storage of food or pathological specimens. Domestic refrigerators in wards must not be used for the storage of blood because of the possible variation in internal temperature beyond the accepted range.

The correct temperature for the storage of blood is 4°C to 6°C. These limits must be rigidly observed to preserve the red cells and minimize the multiplication of chance bacterial contaminants. Blood must never be allowed to freeze. Transfusion of blood which has been frozen and thawed may cause death.

The refrigerator should have an automatic temperature recording device and a battery-operated alarm system; exceptionally, where this is not possible a maximum and minimum thermometer should be provided and the temperature recorded morning and evening in a book. Preferably the automatic temperature recording device should be driven by clockwork (so that it will continue to operate during a mains failure) and should record the temperature of water in a bottle within the refrigerator; the battery-operated alarm should be activated by the air temperature within the refrigerator, the level of activation chosen being such that the alarm will not ring when the refrigerator is opened in the course of normal use.

The time during which blood is out of the refrigerator or other cold storage (such as an insulated box) should be reduced to a minimum, and should not exceed 30 minutes on any one occasion, after which the blood should immediately be cooled again to 4°C to 6°C. Blood which has been out of cold storage for longer periods should not be reserved for future use but should be appropriately labelled and set aside for return to the regional transfusion centre. Similarly, bottles which have been opened or punctured for sampling and not used within 24 hours, although subsequently kept at 4°C since sampling, should not be reserved for future use, except on the instructions of the pathologist in charge. Containers of blood which have been partly used should always be discarded. (See Sections V (xv) and VIII 1 (ii)).

Sometimes there is delay between the time at which blood is issued from the blood bank and the time when it is to be used; sometimes requests are made for blood to be issued, for example, to the operating theatre, in case it may be needed. On such

occasions the blood should be kept in a refrigerator at 4°C to 6°C until it is used, or if there is no refrigerator, it should be issued in an insulated box.

It is advisable to reserve a clearly defined part of the refrigerator for containers of time-expired blood and blood which has become unfit for use for any other reason. These should not be discarded or allowed to accumulate but should be returned to the regional transfusion centre at the earliest opportunity.

An accurate record of issues must be kept. (See Section VI).

2. CONCENTRATED RED CELLS are stored in the same way as whole blood. It is usual for concentrated red cells to be prepared from blood which is as fresh as possible and, in any case, less than 14 days old. If concentrated red cells have been prepared from blood collected in a bottle they must be transfused within 12 hours of separation.

3. DRIED PLASMA

(i) *Reconstitution of dried plasma.* Each bottle issued is accompanied by a bottle containing 400 ml sterile pyrogen-free distilled water. Unscrew the caps of the bottle containing the water and the bottle of dried plasma. If possible flame the tops of the bottles; then pour the water into the bottle of dried plasma and replace the cap at once. Solution is helped by gentle shaking and should be complete in 4–5 minutes. An opaque solution results due to lipoids in fine suspension. Dried plasma is bottled in dry nitrogen and hermetically sealed. If, after adding water, complete solution is delayed beyond 10 minutes or if a gel forms, the contents should not be used. If the seal is found to be damaged, bacteria may have gained entry to the interior of the bottle, and the contents should not be used.

Reconstituted dried plasma must be used without delay. If not used within 3 hours it must be discarded.

(ii) *Storage:* Dried plasma should be stored at a temperature below 25°C in a dry, dark place. Refrigeration is not necessary.

4. PLASMA PROTEIN FRACTION (Human Albumin Fraction Saline)

(i) Plasma protein fraction should not be used unless it is crystal clear and free of deposits.

(ii) Storage: Plasma protein fraction should be kept between 2°C and 25°C in the dark. It should not be frozen.

5. DRIED HUMAN ALBUMIN

(i) Reconstitution: If the seal is found to be damaged the contents should not be used. Each bottle contains 25 g freeze dried protein. Reconstitute by adding the appropriate volume of sterile pyrogen-free distilled water if a solution containing between 15 g and 25 g per cent protein is required. If a solution containing between 5 g and 15 g per cent protein is required, the contents should be reconstituted with the appropriate volume of 5 g per cent dextrose solution. The reconstituting fluid should be added with the precaution mentioned in 3 (i) of this section. The time needed for complete solution and the colour of the resultant fluid will depend upon the concentration being prepared. The bottle should be shaken gently and frothing avoided. Reconstituted albumin must be used without delay; if not used within 3 hours it must be discarded. The reconstituted albumin solution should not be used unless it is transparent.

(ii) *Storage:* Dried human albumin should be stored at room temperature below 25°C in a dry dark place. Refrigeration is not necessary.

6. FRESH FROZEN PLASMA AND CRYOPRECIPITATE

(i) These products are thawed by immersing in a water bath at a temperature not greater than 37°C and should then be used immediately. It may be necessary to wash out the plastic bag or bottle containing cryoprecipitate with sterile pyrogen-free saline solution, to avoid losing significant amounts of clotting Factor VIII.

(ii) *Storage:* Fresh frozen plasma and cryoprecipitate are stored frozen preferably at −25°C or below.

7. DRIED HUMAN ANTIHAEMOPHILIC GLOBULIN

(i) *Reconstitution:* Dried antihaemophilic globulin should be reconstituted immediately before use in accordance with the instructions on the label. Normally the dried contents of the bottle should be allowed to reach room temperature before they are mixed and the solution must not be chilled subsequently. Reconstituted antihaemophilic globulin must be used without delay; if not used within 3 hours it must be discarded.

(ii) *Storage:* Dried antihaemophilic globulin should be stored at 4°C or below.

8. DRIED FACTOR IX CONCENTRATE

(i) *Reconstitution:* Dried Factor IX concentrate should be reconstituted immediately before use in accordance with the instructions on the label. On no account should this material be transfused more than 3 hours after reconstitution. The empty bottles should be destroyed and must not be reused. (Warning: *Concentrates of prothrombin are potentially dangerous because of activation to thrombin which may take place in material stored in solution*).

(ii) *Storage:* Dried Factor IX concentrate should be stored in the dark at 4°C or below.

9. DRIED FIBRINOGEN

(i) *Reconstitution:* Each bottle contains the dried fibrinogen from 200 ml 1·5 to 2·0 g per cent fibrinogen solution. The dried solids should be dissolved in 200 ml sterile pyrogen-free distilled water in the manner described for dried plasma. Fibrinogen dissolves slowly: the bottle should be shaken only very gently, otherwise frothing will occur. Reconstituted fibrinogen must be used without delay; it not used within 3 hours it must be discarded.

(ii) *Storage:* as for dried plasma.

10. PLASMA SUBSTITUTES

(i) Solutions of plasma substitute should not be used unless they are crystal clear and free from deposits.

(ii) *Storage:* Solutions of plasma substitute should be stored at a temperature below 25°C in a dry, dark place. Refrigeration is not necessary.

III Volume and Rate of Transfusion

Dogmatic directions cannot be given concerning the volume and rate 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. On the other hand, the chronically anaemic patient with an enfeebled myocardium, or patients with respiratory or cardiac disorders, or infective and toxic conditions, must be transfused very cautiously.

(i) In the presence of a severe injury accompanied by internal or external loss of blood, the rapid and adequate restoration of the blood volume is the immediate aim, and sufficient whole blood to raise the systolic blood pressure to at least 100 mg.Hg. should be given. Where sufficient blood is not available reconstituted plasma or plasma protein fraction and blood (in ratio 1 : 2) can be used.

In the previously healthy patient, a rate of 100 ml/minute will usually be tolerated until the BP reaches 100 mm Hg. Thereafter the rate should be slowed and the transfusion continued slowly to maintain the systolic blood pressure at its normal level. The transfusion equipment should not be taken down, since further fluid may be needed during and after operation. For general purposes the patient's systolic blood pressure is a rough guide to the amount of fluid to transfuse. *Therefore, the blood pressure should be recorded regularly throughout the transfusion and at least after each bottle transfused.*

(ii) In treating anaemia it may be assumed that one "standard" bottle or plastic bag of whole blood will raise the haemoglobin in an adult about 1·0 g per cent (7 per cent) and concentrated red cells from two units of whole blood will raise the haemoglobin about 2·0 g per cent (15 per cent). If, in the absence of continuing blood loss, 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. or 88 ml/kg. body weight), the transfusion should be given in two parts, separated by 2 days, and the use of concentrated red cells would be advisable. The rate of administration of concentrated cells should not exceed 40 drops per minute. In severe anaemia with a haemoglobin concentration less than 3·7 g per cent (25 per cent), and particularly if accompanied by 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 the state of filling of the jugular veins should be closely observed. The base of the lungs should be examined at frequent intervals for signs of pulmonary oedema. The careful use of diuretics prior to such a transfusion may be of assistance.

(iii) Similar caution must be used in transfusing patients with a *septic condition* or a *toxaemia.* A large volume of fluid, even if administered slowly over a long period, should not be given as a single continuous transfusion to patients with such conditions; it should be divided and given slowly as a number of small transfusions.

Preferably, no major surgical procedure should be carried out unless the haemoglobin is at least 10·4 g per cent. (70 per cent). If the haemoglobin level cannot be restored by appropriate medical treatment, pre-operative transfusions may have to be given. Such transfusions should be given an adequate time before operation to allow their full benefit to develop and to avoid the possibility of a reaction occurring at a time when it would be masked by anaesthesia.

IV Blood Grouping and Compatibility Testing

Blood grouping and compatibility testing are laboratory procedures and should be performed only by persons, whether doctors or technicians, who have had special instruction in modern techniques of such tests. For this reason no attempt is made to describe these techniques here. Instruction in the techniques of blood grouping and compatibility testing can, if necessary, be obtained at Regional Transfusion Centres.

Whatever form local arrangements may take, and whichever of the various recognised techniques of blood grouping and compatibility testing may be adopted, it is essential that a definite order of procedure be evolved and rigidly followed. The order of procedure, including details of techniques to be used, should be written out and be familiar to the laboratory staff. Exceptionally, if other members of hospital staff have to perform blood grouping tests they should be selected in agreement with the pathologist and should be given instruction in the techniques they should use. The necessary pipettes, tubes, saline solutions etc., should always be kept in the same place. Antisera for use should:

(i) be labelled,
(ii) be of adequate potency,
(iii) have been subjected regularly and frequently to control tests and
(iv) always be kept in the same place in the refrigerator.

There is no laboratory procedure in which the results of erroneous techniques or interpretation are more disastrous than in the grouping and compatibility testing of blood. The result of a mistake may be fatal. The printed directions for carrying out these procedures are deceptively simple and may give a false sense of security. Special training and experience are essential if errors in grouping and compatibility testing are to be avoided. No patient, except in grave emergency, should be given a blood transfusion unless:

(a) the ABO and Rh (D) groups of the patient's and donor's blood have been verified and are the same (see Section IX). Sometimes because of its rarity, blood for a group AB patient, especialy group AB Rh (D) negative, may be in short supply. The pathologist will advise in this situation.

(b) a compatibility test between the patient's serum and the donor's red cells has been done.

Indiscriminate use of Group O blood is undesirable and may be dangerous because the plasma of some Group O donors contains potent anti–A or anti–B antibodies which will destroy the red cells of an A, B or AB recipient. Any group O blood issued for emergency use should be free of high titre anti–A and anti–B haemolysins or agglutinins.

1. BLOOD SAMPLES

(i) *Adults and Children:* The ideal sample for blood grouping or compatibility testing is 5 to 10 ml of blood collected with a dry, sterile syringe, and put into a dry, sterile tube, preferably of glass, because plastic containers may occasionally cause delay in clotting. *It is essential that this sample should be clearly and accurately labelled.* 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. The

needle should be removed from the syringe before the blood is expelled into the test tube, since haemolysis may be caused by the ejection of blood under pressure through a fine bore needle.

(ii) *Infants:* In infants a stab wound may be made in the heel with a disposable lancet and 10 to 20 drops of blood should be collected into a dry sterile tube.

(iii) Great care must be observed when taking blood samples to avoid soiling the outside of the container or the request form with blood.

It is recommended that samples from "high risk hepatitis" patients, for example, jaundiced patients or patients in haemodialysis units, or those known to be positive for Australia (hepatitis associated) antigen (see Section VII 9) should be sent to the laboratory in containers protected by plastic bags, preferably heat sealed.

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

Blood Group	Approximate Frequency per cent in United Kingdom	Agglutinogen Content of Cells	Isoagglutinins Present in Serum
O	46·5	Neither A nor B	Anti–A and Anti–B
A	42·0	A	Anti–B
B	8·5	B	Anti–A
AB	3·0	A and B	Neither Anti–A nor Anti–B

Since Group A occurs almost as frequently as Group O it is wasteful (as well as dangerous) to use Group O blood irrespective of the recipient's blood group.

3. Rh (D) BLOOD GROUPING : The Rh (D) group of every person who is to receive a transfusion should be determined and, with certain exceptions, blood of the appropriate Rh group should always be given (see Section IX). These tests may take up to 2 hours and should be performed only by experienced workers. If there is any doubt of the procedure to be followed in a particular case the hospital pathologist should be consulted.

4. COMPATIBILITY TESTS : Every blood transfusion should be preceded by a compatibility test, the details of which must be recorded. The request for this test should be sent in writing to the laboratory as soon as possible after it has been decided to give a transfusion, in order to avoid haste and to afford time for the repetition of tests should the results prove doubtful. The onus of ensuring that this is done rests with the clinician who is to give the transfusion. A fresh sample of the patient's blood for compatibility testing is normally required before each transfusion, if there has been an interval of more than two or three days since the last transfusion. However, compatibility tests for a series of transfusions, given within the course of a day or two, should all be performed with the original pre-transfusion sample of the recipient's serum. It is thus generally necessary to send a fresh sample of blood for compatibility testing with each request for blood, but a particular effort should be made to ensure

that the first sample is large enough to be used for a series of compatibility tests, if several transfusions are likely to be needed in the course of two or three days.

When application is made for a compatibility test, the full name of the patient, date of birth, ward, hospital number (and the name of the hospital if the blood is being prepared by the regional transfusion centre or at another hospital) and the transfusion and obstetric history should always be given on the application form. If required by local circumstances, the full address of the patient should also be given on the application form.

In an emergency, when delay may endanger life, a modified compatibility test can be done in 30–40 minutes, but the risk of errors is increased by doing tests hurriedly. If delay of this duration is too long, transfusion of plasma, plasma protein fraction, or a plasma substitute should be started and, in the interim, grouping and compatibility tests should be done. *It is emphasized that in very few instances is the urgency so great that a compatibility test cannot be done.*

Much time can be saved if the blood groups and haemoglobin levels of patients awaiting admission for operation, who are likely to need transfusion, are determined and are recorded in their case notes before they enter hospital.

An antibody screening test at this time is of value by alerting the laboratory to the presence of atypical antibodies which may complicate crossmatching procedures.

For some exceptional reason it may be considered that it is undesirable to give plasma, or a plasma substitute, while a compatibility test is done, and that blood must be transfused without such a test. Those in charge of blood banks should decide in advance, if necessary in consultation with the Regional Transfusion Director, the procedure to be followed in such exceptional circumstances. If a compatibility test is not performed, 10 ml of blood should be withdrawn immediately before giving the transfusion and sent to the laboratory for blood grouping and compatibility testing with such containers of blood as may have to be given subsequently.

All samples from patients, which have been used for blood grouping or testing compatibility, should be kept in the refrigerator at 4°C to 6°C or, if serum, frozen, for not less than 2 days and preferably for at least 7 days after the transfusion since they may be needed for the investigation of reactions.

V Administration of Transfusions

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

(i) Always check the group and compatibility label on the bottle or plastic bag with the group and identity of the patient before giving a transfusion to ensure that blood of the correct group will in fact be transfused. The majority of incompatible transfusion disasters occur through neglect of this simple precaution. A double check procedure, as for other dangerous drugs, is advantageous. The patient's full name, hospital number and the name of the ward should be on the label of the bottle of blood to be used. Only in this way can it be assured that blood of the correct group is transfused.

In the United Kingdom blood is labelled in the following colours:—

Group O .... blue	Group B ..... pink
Group A .... yellow	Group AB .... white

Labels in the 'ABO' colours for Rh–negative blood bear a vertical red bar.

(ii) Do not heat blood or plasma before use. It is safe to transfuse blood cold from the refrigerator except under special circumstances, for example, exchange transfusions in infants. If it is necessary to warm blood it is preferable to do this by passing the blood through a sterile plastic disposable heat-exchanging coil in a water bath controlled at 30° to 37°C. If blood must be warmed the doctor who is to give the transfusion, or sister-in-charge, should supervise the process. Blood which has been haemolysed by overheating may cause death.

(iii) Do not leave blood out of the refrigerator or insulated box for longer than 30 minutes.

(iv) Do not reconstitute dried blood products until just before use.

(v) Most transfusions can be given by simple venepuncture. Whenever possible select a vein in the forearm. The antecubital fossa should be avoided because of discomfort to the patient and the difficulty of immobilising the transfusion site in a restless patient.

(vi) Cutting down on a vein is hardly ever justifiable. If, however, cannulation is unavoidable, a vein in the forearm (avoiding the antecubital fossa) is preferable to one in the lower limb, although the saphenous vein may have to be used in an infant or child in order to establish without delay a route for the rapid administration of fluids.

(vii) Apply pressure (50–60 mm.Hg.) with a tourniquet or a sphygmomanometer cuff round the upper part of the limb to distend the veins.

(viii) Employ palpation as well as inspection in selecting a vein. After preparing the skin inject, if necessary, a little local anaesthetic intradermally over the selected vein and leave it for ½–1 minute to take effect.

(ix) Disposable Plastic Giving Sets: Detailed instructions for using these sets are printed on the container. Connect the transfusion apparatus with the bottle or plastic bag and see that it is in working order before starting the transfusion. When used with bottles the piercing needles should be inserted through the segments of the rubber

closure marked '2'. When using a set with a combined air-inlet blood-outlet piercing device, this should be inserted through the recessed segment '2'. *Plastic bags do not require an airway.*

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

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

(xii) The patient should be watched closely especially during the first 30 minutes of a transfusion in order

(a) to see that the desired rate of flow is in fact maintained and

(b) to observe whether any untoward reaction occurs.

(xiii) If the transfusion is not flowing satisfactorily or stops inspect the set to see that the tubing is not kinked and examine the limb proximal to the needle to ensure that the vein is not being compressed, for example, by a rolled-up sleeve.

Adjust the regulating clamp. Inspect the position of the needle and manipulate it gently. If these simple manoeuvres do not re-establish the flow, close the regulating clamp and disconnect the set from the needle. Test the patency of the needle by gentle suction with a sterile syringe partly filled with sterile saline solution; do not try to inject saline through the needle. Test the patency of the set by releasing the regulating clamp. If either the needle or the set is blocked, a fresh needle or set should be substituted. Do not try to clear the obstruction by applying positive pressure in the container.

(xiv) If a very rapid rate of transfusion is essential, for example when resuscitating patients or casualties with severe oligaemic shock, this can be achieved by the use of a rotary pump or, in the case of plastic bags, external pressure can be applied to the bag by a pressure infusor. With some giving sets intermittent compression of the drip chamber is possible. ONE OF THE ABOVE MANOEUVRES SHOULD ALWAYS BE USED IN PREFERENCE TO RAISING THE AIR PRESSURE IN THE CONTAINER BECAUSE OF THE DANGER OF AIR EMBOLISM. (See Section VII 4).

(xv) When the transfusion is completed, return to the laboratory without delay, UNWASHED every container that has held blood or blood product used for transfusion. In the event of some complication, for example, haemoglobinuria or jaundice following transfusion, a sample of the fluid given will then be available for investigation. If no complication has occurred after 2 days, the used bottle or bottles should be returned to the Regional Transfusion Centre. There is difficulty in preserving plastic bags after transfusion because of leakage from the pierced bag. The procedure to be adopted locally should be decided by the pathologist and clinician, in consultation if necessary with the Regional Transfusion Director.

(xvi) Transfusions of blood or plasma or infusions of crystalloid solutions tend to be associated with thrombophlebitis if unduly prolonged. Furthermore, chance contamination of a giving set may lead to a heavy growth of organisms within the

apparatus when its use is extended beyond 12 hours. The incidence of these complications can be reduced by using a new giving set (and possibly changing the site of the venepuncture) after an interval of 12 to 24 hours.

A change of giving set is sometimes specially indicated, for example, if a group AB patient has been transfused with group A blood following which, group AB blood becomes available. The giving set should be changed to avoid the anti–B in the plasma of the group A blood causing agglutinates of AB cells within the giving set. Similarly, when blood of any other ABO group is transfused following an emergency transfusion of group O blood, the giving set should be changed. This is also indicated when a change is made from blood to dextrose solutions and vice versa.

VI Transfusion Records

1. A record of every transfusion should be made in the patient's case notes in addition to the details recorded in the transfusion laboratory. It is not always appreciated that the main reason for accurate recording is the protection of the patient.

THE PATIENT'S RECORDS must show:

(i) Serial numbers of containers of blood or blood products. 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 serum hepatitis. In the latter instance it is important not only to be able to trace the donor bearing the infective agent, but also to be able to trace and withdraw other containers of the same icterogenic batches. Only by the careful and invariable recording of serial numbers of containers of transfusion fluid can this be accomplished. In all cases of suspected post-transfusion serum hepatitis tests of the recipient's serum for Australia (hepatits associated) antigen should be performed. This can normally be done by the Public Health Laboratory Service. THE REGIONAL TRANSFUSION DIRECTOR MUST ALSO BE INFORMED IMMEDIATELY SO THAT FURTHER TESTS CAN BE MADE OF THE BLOOD OF THE DONORS CONCERNED.

(ii) Details of the blood pressure (see Section III (i)). The pulse rate and temperature should also be recorded at the commencement of the transfusion and thereafter at frequent intervals dependent on the clinical condition of the patient.

(iii) The time taken to give the transfusion.

(iv) Results of urine analysis. Any urine voided during the transfusion and in the 24 hours afterwards should whenever possible 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.

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

2. THE LABORATORY RECORDS are the responsibility of the pathologist in charge of the hospital transfusion laboratory. Such records should show the following details of the use of all blood and blood products.

The blood bank register should show:—

(i) Date and time of removal of the blood from the blood bank.

(ii) Name of person fetching the blood from the blood bank.

(iii) Full name, ward, and hospital number or home address of recipient.

(iv) Blood group (ABO and Rh (D)) of recipient.

(v) Serial number and blood group (ABO and Rh (D)) and date of collection of each container of blood transfused.

(vi) Clinical condition necessitating transfusion.

(vii) Reactions, if any, stating—

(a) their nature;

(b) whether patient has a history of miscarriage, still birth, hydropic, anaemic or jaundiced babies, or has had previous transfusions, or injections of blood or plasma.

(viii) Name of doctor giving the transfusion.

The plasma or plasma protein fraction register should show similar information.

3. The doctor in charge of the above records should at regular and frequent intervals satisfy himself that unused units of blood or blood products issued to the wards and theatre have been returned to the hospital blood bank.

VII Complications and Dangers of Transfusion

1. FEBRILE REACTIONS:

Classification.	Grade 1.	Rise of temperature to 37·8°C (100°F).
	Grade 2.	Rise of temperature above 37·8°C (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. Most are probably due to pyrogens. A febrile reaction, grade 2 or 3, during transfusion is an indication for stopping the transfusion. Fluctuations in temperature should be investigated to distinguish if possible those due to the patient's disease from those due to the transfusion.

Leucocyte antibodies may cause pyrexia, headache and rigor but are not usually dangerous. (See Section I.13).

2. OVERLOADING OF THE CIRCULATION AND PULMONARY OEDEMA

The danger of circulatory overloading exists mainly in patients with heart disease, chronic anaemia and cachectic states, severe sepsis, toxaemia, etc., in babies and in aged persons. The risk will arise if transfusion is too rapid or if the quantity of fluid transfused is too great for the particular case. Circulatory overloading can be prevented by giving transfusions slowly and by avoiding transfusion of excessive amounts of fluid. The ideal material for severe anaemic states is concentrated red cells.

3. HAEMOLYSIS IN TRANSFUSION

The chances of a haemolytic reaction due to incompatible transfusion are reduced by using only homologous blood, i.e., blood of the same ABO and Rh (D) groups as those of the recipient, and which has been shown by a reputable technique to be compatible with the blood of the recipient.

Group O blood should not be used indiscriminately, since the antibodies in the blood of certain group O donors are sufficiently potent to destroy the red cells of a group AB, A or B recipient and may thereby cause a dangerous haemolytic reaction. Very occasionally a similar situation may arise when group A or group B blood is given to a group AB recipient.

A further danger with group O Rh negative blood is that an Rh positive recipient may have been immunised to one of the Rh subgroups, for example $\bar{c}$ or $\bar{e}$. There are, however, rare cases, especially some treated by "flying squads", where the delay caused by any testing procedures would endanger life, and here it is justifiable to use group O Rh negative blood which has been shown to be free from dangerous anti–A and anti–B antibodies.

A haemolytic reaction, similar to that following the transfusion of incompatible blood, may follow the transfusion of out-dated blood, or blood which has been haemolysed by freezing, overheating or infection.

The symptoms of a haemolytic reaction vary from case to case. Usually, there is a rapidly developing febrile reaction, sometimes after as little as a few 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.

In severe cases hypotension may develop and there may be a marked deterioration in the peripheral circulation. 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 or anaesthetised patient. Haemoglobinuria and jaundice may occur. Several hours will usually elapse before the onset of jaundice and it may be delayed for a few days. An acute defibrination syndrome may occur during an episode of acute intravascular haemolysis, especially as a result of a large incompatible blood transfusion. This may lead to multiple haemorrhages of varying size in many different organs including the brain and can be fatal. If such an episode occurs it presents as an acute medical emergency for which urgent advice and speedy diagnosis is essential. The use of fibrinogen may help to control the episode.

Treatment of haemolysis following transfusion: When haemolysis following transfusion, due to incompatibility or any other cause, is suspected, the transfusion should be stopped immediately and expert advice should be obtained. Treatment should be based on the principle of assisting the renal excretion of haemoglobin where this is possible, but it is important to appreciate that the patient's renal function may have been so impaired by the haemolytic reaction that the secretion of urine is temporarily diminished. With correct management, for example controlled fluid and electrolyte balance, the patient can be tided over this phase of renal failure and restoration of kidney function may be expected, within 7–21 days in most cases. While awaiting expert advice therefore the following treatment may be instituted:

(i) If the patient shows signs of oligaemic shock, steps must be taken immediately to restore the general circulation by transfusion of compatible blood, plasma, or plasma protein fraction. Delay increases the risk of renal damage. Low molecular weight dextrans are contra-indicated.

(ii) This infusion should be monitored by measurement of central venous pressure and should be discontinued when central venous pressure rises above normal levels.

(iii) A fluid balance chart must be kept.

(iv) All urine voided should be kept and the urinary urea and sodium concentration should be measured.

If the patient is oliguric up to 25 g. of mannitol can be infused either as 100 ml of 25% or 250 ml of 10% solution (Injection of Mannitol B.P.).

In the absence of satisfactory urinary output when the central venous pressure is normal or elevated above normal further attempts should NOT be made to promote a diuresis and advice from a Renal Unit should be sought.

The case should be regarded as one of acute intrinsic renal failure and this may be confirmed by finding a urinary sodium concentration of more than 20 mEq/l and a urinary urea concentration which approximates to that of blood. While the advice is awaited the plasma potassium should be measured and an ECG performed. If the plasma potassium is greater than 6 mEq/l or there is evidence of hyperkalaemia on the ECG, prompt treatment is required and the investigations will allow emergency measures to be instituted as soon as the expert advice is available.

Once acute intrinsic renal failure is established the patient should be moved whenever possible to a Renal Unit so that dialysis can be carried out until recovery from acute renal failure occurs.

This happens in 95% of cases within 21 days of the incident. The course of acute renal failure passes through three phases:

(a) Oliguric phase: During this phase the urine volume is less than 400 mls/24 hours. Treatment is aimed at maintaining fluid and electrolyte balance and limiting protein catabolism. Prophylactic dialysis is generally performed where necessary rather than waiting for the patient to develop symptoms of uraemia. The advantage of prophylactic dialysis is that an adequate protein and calorie intake can be maintained, minimising the risk of infection and encouraging recovery from the primary illness.

(b) The early diuretic phase: This is heralded by a progressively increasing urine volume which may double on successive days but the kidney is unable to concentrate and the management of renal failure must continue. This phase may last for two to five days.

(c) Late diuretic phase: The kidney commences to concentrate and regains its normal capacity for controlling fluid, electrolyte and nitrogenous excretion.

4. EMBOLISM

Air Embolism: Because of the danger of air embolism a procedure which involves forcing air directly into the container should never be used to achieve a rapid transfusion. When resuscitating patients with severe oligaemic shock alternative measures are available. (See Section V (xiv)).

If, for some exceptional reason, positive pressure can only be applied by raising the air pressure within the bottle, the transfusion must be CONTINUOUSLY supervised by a doctor who understands the dangers, and the pressure must NEVER be continued after the bottle is three-quarters empty. Positive pressure, however applied, must never be used to overcome an obstruction in the giving set.

Air embolism may also result from leaks or faults in the apparatus, or from faulty cannulation of a vein.

If air embolism is suspected the patient should be placed on his left side and kept in this position for two hours. Only gradually should his position then be changed and the patient closely observed for any symptoms.

5. THE ADDITION OF MEDICAMENTS TO BLOOD

No medication should be added to the container and the practice of injecting substances through the set should be used with discrimination. If essential, they should only be injected according to instructions supplied with the giving set through the medication site with the flow 'clipped off'. As an alternative a three-way or four-way disposable stop-cock can be interposed between the set and the needle in the patient's vein.

6. ALLERGIC REACTIONS

Skin rashes, urticarial weals and angioneurotic oedema may complicate transfusion. Treatment with antihistamine drugs is usually sufficient but adrenaline therapy may be necessary in severe reactions.

7. TRANSFUSION OF INFECTED BLOOD

Never leave blood out of cold storage longer than 30 minutes at a time. Interruption of refrigeration may allow chance contaminating bacteria to multiply and blood so infected may cause a severe or fatal reaction. The initial symptoms may be indistinguishable from those of a haemolytic reaction due to incompatible blood but the characteristic feature is the onset of extreme hypotension with warm extremities. Vomiting and diarrhoea may occur and there may be complaint of severe pain in the abdomen and extremities. The outcome appears to depend upon the degree of contamination of the transfused blood.

Therapy with antibiotics and infusion of such substances as plasma, pressor agents and hydrocortisone form the basis of treatment. Investigation of a suspected case is dealt with under Section VIII (v).

Incidents in which transfusion of infected blood or blood derivative has occurred or is suspected must be reported immediately to the Regional Transfusion Director.

8. DONOR-TRANSMITTED INFECTION

Blood is collected by the regional transfusion centres from donors in normal health and, as far as can be ascertained, free from diseases transmissible by transfusion. All such blood is subjected to a syphilis test. Although efforts are made by those concerned to ensure that donors are free from syphilis or other transmissible disease, when fresh blood is taken from a donor and transfused before appropriate tests have been completed an increased risk is present and must be accepted by the clinician.

9. SERUM HEPATITIS

Although the rejection of blood donations giving positive tests for the presence of Australia antigen or its antibody diminishes the risk of transmitting hepatitis, the methods of screening at present applicable do not detect antigen or antibody in every instance. Until more sensitive methods can be used routinely, the transmission of hepatitis will therefore contine to be a risk associated with the use of blood, concentrated red cells, platelets, fresh frozen plasma, cryoprecipitate, dried plasma, human antihaemophilic globulin, Factor IX concentrate, fibrinogen and thrombin. Human plasma protein fraction and human albumin are rendered non-icterogenic by heating at 60°C for 10 hours; human immunoglobulin prepared by ethanol fractionation is not icterogenic.

Serum hepatitis is clinically indistinguishable from infective hepatitis. The incubation period may extend to 180 days. It is thought to be caused by a virus.

Serial numbers of bottles of blood and blood products should invariably be recorded in the case notes (see Section VI 1). If several bottles, for example of plasma or fibrinogen, are to be given to one patient they should if possible be of the same batch in order to reduce the risk of transmitting hepatitis.

Cases of serum hepatitis, together with the serial number of the containers of blood and other blood products involved must, as already recommended, be reported immediately to the Regional Transfusion Director so that donors can be investigated and any unused materials of the same batch may be withdrawn.

VIII Investigation of Transfusion Reactions

1. In the event of a febrile reaction or untoward symptoms complicating a transfusion the hospital transfusion laboratory should be notified. All severe reactions should also be notified by the hospital transfusion laboratory to the Regional Transfusion Director. The following specimens are needed, initially, to make an investigation :—

(i) The blood samples used for the compatibility test before transfusions. Such samples should be kept in the refrigerator for not less than 2 days after every transfusion. (See Section IV 4).

(ii) The remains of blood or plasma in the containers used for transfusion. All containers of blood or blood products used for transfusion should be kept in the laboratory at 4°C to 6°C for 48 hours after use lest investigations prove necessary. (See Section V (xv)).

(iii) A 10–20 ml sample of blood, from a vein other than the one used for the transfusion, collected with a dry, sterile syringe as soon as possible after the reaction. Put about 2 ml into an anticoagulant bottle and the remainder into a dry sterile container.

(iv) A clean sample of urine. All urine voided for 2 or 3 days should be measured and examined; abnormally coloured urine should be conserved for investigation.

(v) In the case of a reaction suspected to be due to infected blood a sample should be collected for blood culture and cultures should be made of the remnants in the containers concerned.

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 upon 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. If the observed rise of haemoglobin concentration does not approximate to the expected rise and no obvious cause, for example, haemorrhage, can be found, the possibility of a haemolytic reaction, the so-called "silent" or "inapparent reaction", should be considered.

IX The Rh System

The Rh group of a recipient should always be determined, since up to 50 per cent of Rh negative recipients, irrespective of their sex, may develop antibodies to fhe Rh factor if transfused with Rh positive blood.

Moreover, a single transfusion of Rh positive blood may so sensitize an Rh negative female to the Rh factor that any subsequent Rh positive offspring may be affected with haemolytic disease of the newborn. Ideally, therefore, all patients should be transfused only with blood of homologous Rh group.

Immunization of an Rh negative mother, can also be caused by passage across the placenta of red cells from an Rh positive foetus, the Rh factor being inherited from the father. When transplacental passage of cells occurs, it probably occurs in all but a few cases at the time of delivery. That sensitization occurs at this time is suggested by the fact that the intramuscular injection of anti–D immunoglobulin within 60 hours of birth brings about the disappearance of foetal Rh positive cells from the maternal circulation and prevents sensitization of the mother. This form of preventive treatment fails in less than 2 per cent of cases. A uniform dose of at least 100 μg anti–D immunoglobulin is adequate to protect the majority of Rh negative mothers at risk. A greater dose is given when it is demonstrated by the Kleihauer technique that a large transplacental haemorrhage has occurred.

Any immunized person, if transfused subsequently with Rh positive blood, may respond by destroying the donor's red cells; a fatal haemolytic reaction may occur.

There are very few occasions on which there is not time to group the patient and do a direct matching test. In some grave emergencies there may not be time to do this and the tendency is then to use Group O Rh negative blood although only about 1 out of every 6 patients will, in fact, be Rh negative. If the ABO group is known, however, use can be made of Rh negative blood of the same ABO group.

Rh negative blood is essential for the transfusion of Rh negative females before and during the child-bearing age, and for patients already sensitized to the Rh factor. Rh negative blood of any ABO group is also relatively scarce and therefore its use for patients who are not Rh negative accentuates its scarcity for those patients who should only receive such blood.

The relative scarcity of Rh negative blood is clear from the table, which shows the approximate percentage of Rh negative individuals by ABO groups in a random sample of United Kingdom population.

	O	A	B	AB	Totals
Rh positive	38·6	34·9	7·0	2·5	83·0
Rh negative	7·9	7·1	1·5	0·5	17·0
Totals	46·5	42·0	8·5	3·0	100·0

It may happen exceptionally that, in an emergency, when a recipient is known to be Rh negative, no Rh negative blood is available. In many of these instances plasma, plasma protein fraction or a plasma substitute can be used satisfactorily while blood of the appropriate group is obtained and blood grouping and direct-matching tests are being done. The value of these fluids for this purpose appears to be insufficiently appreciated. Nevertheless, there may be occasions when blood must be given at once and only Rh positive blood is available for an Rh negative unsensitized patient. In such circumstances, the clinician must be told of the position by the pathologist and, if he agrees with the proposal to give Rh positive blood, the risk must be taken. At other times, because of a local shortage of Rh negative blood for the foreseeable needs of Rh negative females before and during the child-bearing age, and of patients already sensitized to the Rh factor, it may be necessary to use Rh positive blood for Rh negative nulliparous females past the menopause who have not been transfused before and for Rh negative males who have not been transfused before. Here again the risk may have to be taken (after consultation between pathologist and clinician), but consideration should always be given to the use of plasma, plasma protein fraction or a plasma substitute, as already mentioned, while it is confirmed with the regional transfusion centre that there is no possibility of Rh negative blood becoming available in time. Obviously all hospital staff should regard it as a duty in their use of transfusion therapy to avoid the wasteful use of Group O Rh negative blood at any time and so to prevent this dilemma from arising.

If for any reason blood has been given to a patient of unknown Rh group, the pre-transfusion sample should be submitted for Rh grouping without delay.

The Rh negative patient who has received Rh positive blood must thereafter be considered a "dangerous recipient". Reliance for detecting such patients must rest essentially upon obtaining a proper history especially of previous transfusions or injections of blood and following the correct procedure whenever a transfusion is to be given, ie, using a request form and performing the blood grouping and direct matching tests by suitable techniques.

Note. In order to provide anti–D immunoglobulin for the prevention of Rh immunisation in Rh negative women, a small number of Rh negative men have volunteered to receive immunising injections of Rh positive red cells. This fact must be taken into account should they ever require a transfusion and they must be considered as "dangerous recipients".

If an Rh negative female, before or during child-bearing years, inadvertently receives Rh positive blood, it may be possible to prevent the development of Rh antibodies by giving anti–D immunoglobulin. In these circumstances the hospital pathologist and Regional Transfusion Director should be consulted about using anti–D immunoglobulin.

Further protection for such a patient against trouble from future transfusions may also be afforded by carrying out the following procedures :—

(a) Entry, by the clinician in charge of the patient, of full details of transfusions in the case history notes which should be distinctively marked.

(b) Examination of the patient's serum, if possible, and preferably at the regional transfusion centre, for the presence of atypical antibodies, bearing in mind that the appearance of antibodies may be delayed for 3 to 4 months. A negative result is, of course, not to be taken as removing the patient from the group of dangerous recipients.

An infant suffering from haemolytic disease of the newborn, due to Rhesus immunization of an Rh negative mother, may require a transfusion with Rh negative blood of its own ABO group although the infant is Rh positive.

Note: Sensitization of the mother to antigens of other blood group systems (for example ABO and Kell) may also occur during pregnancy and be associated with haemolytic disease of the newborn. In such cases expert advice should be taken.

Regional Transfusion Centres

England and Wales

Newcastle Region	Regional Transfusion Centre Westgate Road Newcastle upon Tyne NE4 6QB Tel. 0632 37804
Leeds Region	Regional Transfusion Centre Bridle Path Leeds LS15 7TW Tel. 0532 645091
Sheffield Region	Regional Transfusion Centre Longley Lane Sheffield S5 7JN Tel. 0742 387201
East Anglia Region	Regional Transfusion and Immuno-Haematology Centre Long Road Cambridge CB2 2PT Tel. 0223 45921
N.W. Met. Region	North London Blood Transfusion Centre Deansbrook Road Edgware HA8 9BD Tel. 01–952 5511
N.E. Met. Region	N.E. Met. Regional Blood Transfusion Centre Crescent Drive Brentwood, Essex Tel. Brentwood 3545
S.E. and S.W. Met. Region	South London Transfusion Centre 75 Cranmer Terrace London SW17 0RB Tel. 01–672 8501 South London Transfusion Sub-Centre David Salomon's House Southborough Nr Tonbridge Kent Tel. 0892 28172

Oxford Region	Regional Transfusion Centre Churchill Hospital Headington Oxford OX3 7LJ Tel. 0865 65711
S.W. Region	S.W. Regional Transfusion Centre Southmead Bristol BS10 5ND Tel. 0272 628021
Cardiff Region (South and Mid Wales)	Regional Transfusion Centre Rhyd-Lafar St Fagans Cardiff CF5 6XF Tel. 044–725 302
Birmingham Region	Regional Transfusion Centre Vincent Drive Birmingham B15 2SG Tel. 021–472 3111
Manchester Region	Regional Transfusion Centre Roby Street Manchester M1 3BP Tel. 061–236 8181
(Lancaster)	Regional Transfusion Sub-Centre Quernmore Road Lancaster Tel. 0524 3456
Liverpool Region	Regional Transfusion Centre West Derby Street Mount Vernon Liverpool L7 8TW Tel. 051–709 7272
Wessex Region	Regional Transfusion Centre Coxford Road Southampton SO9 5UP Tel. 0703 776441

Scotland

North of Scotland
Blood Transfusion Service
Raigmore Hospital
Inverness
Tel. 0463 34151

Aberdeen and North-East of Scotland
Blood Transfusion Service
Royal Infirmary
Foresterhill
Aberdeen
AB9 2ZW
Tel. 0224 23423 Extn. 2322

East of Scotland Blood Transfusion Service
Royal Infirmary
Dundee
Tel. 0382 23125

Edinburgh and South-East of Scotland
Blood Transfusion Service
Royal Infirmary
Edinburgh
EH3 9YW
Tel. 031–229 5255

Glasgow and West of Scotland
Blood Transfusion Service
Law Hospital
Carluke
Lanarkshire
ML8 5ES
Tel. 0552 3 73315

Printed in Scotland by Her Majesty's Stationery Office at HMSO Press, Edinburgh
Dd 224042 55M 6/73 (10112)