Transfusion of blood and blood products

Objectives

- To knew the indecations and risk of blood transfusion.
- The use of blood and blood products

The indications for transfusion in surgical practice are as follows.
• Following traumatic incidents where there has been severe blood loss, or haemorrhage from pathological lesions, for example from the gastrointestinal tract.
• During major operative procedures where a certain amount of blood loss is inevitable, for example abdominoperineal or cardiovascular surgery.
• Following severe burns where, despite initial fluid and protein replacement, there may be associated haemolysis.
• Postoperatively in a patient who has become severely anaemic.
• Preoperatively, usually in the form of packed cells given slowly (see Blood fractions and Complications, later) in cases of chronic anaemia where surgery is indicated urgently, i.e. where there is inadequate time for effective iron or other replacement therapy, or where the anaemia is unresponsive to therapy, for example aplastic anaemia.
• To arrest haemorrhage or as a prophylactic measure prior to surgery, in a patient with a haemorrhagic state such as thrombocytopenia, haemophilia or liver disease (see Blood fractions, later).

Preparation of blood products for transfusion

It is important that blood donors should be fit and with no evidence of infection, in particular hepatitis and human immunodeficiency virus (HIV) infection acquired immunodeficiency syndrome (AIDS), which are transmitted in donor blood.
Blood is collected into a sterile commercially prepared plastic bag with needle and plastic tube attached in a complete, closed sterile unit.
With the donor lying on a couch, a sphygmomanometer cuff is applied to the upper arm and inflated to a pressure of 70 mmHg (9.3 kPa) or 80 mmHg (10.6 kPa). After introducing 0.5 ml of local anaesthetic, a 15G needle is introduced into the median cubital vein and 410 ml of blood allowed to run into the bag containing 75 ml of anticoagulant solution (CPD — citrate potassium dextrose).
During collection, the blood is constantly mixed with the anticoagulant to prevent clotting, and at the end of the procedure the tube is clamped and the needle removed. Specimens for use in blood grouping and cross-matching procedures may be obtained by clamping off small sections of the plastic tubing containing the donor blood.

Blood storage

All blood for transfusion must be stored in special blood bank refrigerators controlled at 40C ±20C. Blood allowed to stand at higher temperatures for more than 2 hours is in danger of transmitting infection.
CPD blood has a shelf-life of 3 weeks (CPDA 1—5 weeks). The red blood cells, or erythrocytes, suffer a temporary reduction (24—72 hours) in their ability to release oxygen to the tissues of the recipient, so if a patient requires an urgent and massive transfusion it is wise to give 1 or 2 units of blood which are less than 7 days old.

White blood cells

White blood cells are rapidly destroyed in stored blood.

Platelets

At 40C the survival of platelets is considerably reduced, and few are functionally useful after

24 hours. Platelets which are separated (see Blood fractions below) show good survival even after 72 hours.

Clotting factors

Like platelets, clotting factors VIII and V are labile and their levels fall quickly.

Blood fractions

Whole blood may be divided into various fractions. This is not only more economical of blood donors, but certain fractions are more appropriate than whole blood transfusion for certain clinical conditions. Fractionation procedures are relatively safe and simple, using sealed sterile plastic bag units.

Packed red cells

Packed red cells are especially advisable in patients with chronic anaemia, in the elderly, in small children and in patients in whom introduction of large volumes of fluid may cause cardiac failure. Packed red cells are suitable for most forms of transfusion therapy, including major surgery, especially in association with clear fluids. Good packing can be obtained by letting the blood sediment and removing the plasma, or by centrifugation of whole blood at 2000—2300g for 15—20 minutes.

Platelet-rich plasma

Platelet-rich plasma is suitable for transfusions to patients with thrombocytopenia who are either bleeding or require surgery. It is prepared by centrifugation of freshly donated blood at 15 0—200 g for 15—20 minutes.

Platelet concentrate

Platelet concentrate for transfusion to patients with thrombocytopenia is prepared by centrifugation of platelet rich plasma at 1200—15 00 g for 15—20 minutes.

Plasma

This is removed after centrifugation of whole blood at 2000—23 00 g for 15—20 minutes and it may be further processed or fractionated in various ways.

Human albumin 4.5 per cent. Repeated fractionation of plasma by organic liquids followed by heat treatment results in this plasma fraction, which is rich in protein but free from the danger of transmission of serum hepatitis. This may be stored for several months in liquid form at 40C and is suitable for replacement of protein, for example following severe burns.

Fresh frozen plasma. Plasma removed from fresh blood obtained within 4 hours is rapidly frozen by immersing in a solid carbon dioxide and ethyl alcohol mixture. This is stored at —400C and is a good source of all the coagulation factors. It is the treatment of choice when considering surgery in patients with abnormal coagulation due to severe liver failure. It may also be given in any of the congenital clotting factor deficiency diseases in their milder forms, especially Christmas disease (Factor IX deficiency) or haemophilia (Factor VIII deficiency).

Cryoprecipitate. When fresh frozen plasma is allowed to thaw at 40C a white glutinous precipitate remains and, if the supernatant plasma is removed, this cryoprecipitate is a very rich source of Factor VIII. It is stored at —400C and is immediately available for treatment of patients with haemophilia (Factor VIII deficiency). The advantage of cryoprecipitate treatment in haemophilia is the simplicity of administering large quantities of Factor VIII in relatively small volumes by intravenous injection. It is also a rich source of fibrinogen, of value in hypofibrinogenaemic states.

Factor VIII concentrate and Factor IX concentrate. Factor VIII concentrate and Factor IX concentrate are stored in freeze-dried form.

Fibrinogen. Fibrinogen is prepared by organic liquid fractionation of plasma and stored in the dried form. When reconstituted with distilled water, it is used in patients with severe depletion of fibrinogen (e.g. disseminated neurovascular coagulation or congenital afibrinogenaemia). It does, however, carry a high risk of hepatitis.

SAG-mannitol blood. Because of the need for blood products, there will be an increasing use

of SAG-M blood. A proportion of blood donations will have all the plasma removed, which will be replaced with 100 ml of a crystalloid solution containing: sodium chloride (877 mg), adenine (16.9 mg), glucose anhydrous (181 mg) and mannitol (525mg).
This allows good viability of the cells, but there is practically no protein (albumin) present. For top-up transfusions for anaemia, this will not constitute a problem.
For healthy adults, the plasma albumin level will not be compromised by a replacement transfusion of up to 4 units of SAG-M blood, after which whole blood should be used. If this is not available, more SAG-M blood may be given, supplemented by 1 unit (400 ml) of 4.5 per cent human albumin solution BP for every 2 units of SAG-M blood. After 8 units of SAG-M red cells have been transfused, the need for fresh frozen plasma and platelets should be considered, after first checking the coagulation status and platelet count.

Blood grouping and cross-matching

Human red cells have on the cell surface many different antigens. For practical purposes, there are two groups of antigens which are of major importance in surgical practice: antigens of the ABO blood groups and antigens of the rhesus (Rh) blood groups.

Antigens of the ABO blood groups

These are strongly antigenic and are associated with naturally occurring antibodies in the serum. Individuals show four different ABO cell groups

Antigens of the rhesus blood groups

The antigen of major importance in this group is Rh(D), which is strongly antigenic and is present in approximately 85 per cent of the population in the UK. Antibodies to the D antigen are not naturally present in the serum of the remaining 15 per cent of individuals, but their formation may be stimulated by the transfusion of Rh-positive red cells. Such acquired antibodies are capable, during pregnancy, of crossing the placenta and, if present in a Rh-negative mother, may cause severe haemolytic anaemia and even death (hydrops fetalis) in a Rh-positive fetus in utero. The other minor blood group antigens may be associated with naturally occurring antibodies, or may stimulate the formation of antibodies on relatively rare occasions.

Incompatibility

If antibodies present in the recipient's serum are incompatible with the donor's cells, a transfusion reaction will result. This is the result of agglutination and haemolysis of the donated cells leading in severe cases to acute renal tubular necrosis and renal failure. For this reason, therefore, it is essential that all transfusion should be preceded by:

- ABO and rhesus grouping of the recipient's and donor's cells so that only ABO and Rh(D) compatible blood is given;
- direct matching of the recipient's serum with the donor's cells to confirm ABO compatibility and to test for rhesus and any other blood group antibody present in the serum of the recipient.

Blood grouping and cross-matching require full laboratory procedures and take 1 hour. In emergencies it may be necessary to reduce this time, but the risk of doing this must be weighed against the danger to the patient by the delay in transfusion entailed by the full procedures. In such emergencies, it may be advisable to restore the patient's blood volume by saline, gelatin (e.g. Haemaccel), dextran or human albumin 4.5 per cent until blood has been made available. Alternatively, donor blood, group 0-negative, which is compatible with the majority of individuals, should be given and this should always be available in acute emergency situations.

Giving blood

Blood transfusion is commenced by:

- selection and preparation of the site;

• careful checking of the donor blood: this should bear a compatibility label stating the patient's name, hospital reference number, ward and blood group;
•insertion of the needle or cannula — the latter may be valuable if intravenous therapy is required for any length of time;
•giving detailed written instructions as to the rate of flow, for example 40 drops/mm allows one 540 ml unit of blood to be transfused in 4 hours.
In acute emergencies, it may be necessary to increase the rate of flow and it is possible to give 1—2 units in 30 minutes using a pressure cuff around a plastic bag of blood.
Warming blood. During cardiopulmonary operations, the blood must be warmed before reaching the patient by passing it through a carefully temperature-regulated blood warming unit, thus reducing the risk of cardiac arrest from large volumes of cold blood direct from the refrigerator.
Filtering blood. A filter (Pall) with an absolute filtration rating of 40 micron will filter off platelet aggregates and leucocytes membranes in stored blood.

Autotrans fusion

This is an old, well-tried method of immediately restoring a patient's blood volume, by transfusion with his or her own blood. In an emergency, for example, in a case of ruptured ectopic gestation, the blood is collected from the peritoneal cavity and put into a sterile container suitable for connecting to transfusion tubing. The classical method of filtration of this blood to prevent the transfusion of any small clots is to place a piece of sterile gauze within the container. Nowadays, special autotransfusion apparatus is being marketed. For major elective procedures, the patient may 'donate' his or her own blood, withdrawal and storage taking place up to 3 weeks before it is required. Natural blood volume and most of the red cell recovery will have taken place in that time.

Complications of blood transfusion

Congestive cardiac failure

This is especially liable to occur in the elderly or where there is cardiovascular insufficiency, and may result from too rapid infusion of large volumes of blood. It is advisable in the individual with chronic anaemia to give packed red cells and, at the same time, give diuretic drugs. The transfusion should be given slowly, i.e. I unit over 4—6 hours and, if necessary, on two separate occasions.

'Transfusion reactions

These may be the result of the following problems:
• **Incompatibility**. This should be avoided if the correct procedures of grouping and cross-matching have been adopted but, in fact, it is nearly always due to human error in the collection, labelling or checking of the specimens and donor bags. The patient develops a rigor, temperature and pain in the loins, and may become extremely alarmed. The transfusion should be stopped immediately, and a fresh specimen of venous blood and urine from the patient sent together with the residue of all the used units of donor blood to the laboratory for checking.
A close watch should be kept on the patient's pulse, blood pressure and urinary output. Frusemide 80—120 mg i.v. should be given to provoke a diuresis, and repeated if the urine output falls below 30 ml/hour. Dialysis may be necessary.
• **Simple pyrexial reactions** in which the patient develops pyrexia, rigor and some increase in pulse rate. These are the result of 'pyrogens' in the donor apparatus and are largely avoided by the use of plastic disposable giving sets.
• **Allergic reactions** in which the patient develops mild tachycardia and an urticarial rash; rarely an acute anaphylactic reaction may occur. This is the result of allergic reaction toplasma products in the donor blood. The reaction is treated by stopping the transfusion and giving an antihistamine drug (chlorpheniramine 10 mg or diphenhydrazine 25 mg).

• **Sensitisation to leucocytes and platelets**. This is not uncommon in those patients who have received many transfusions in the past, for example for thalassaemia, refractory anaemia or aplastic anaemia. The individual develops antibodies to donated white cells or platelets, which cause reactions with each transfusion. They may be minimised by giving packed red cells from which plasma and 'huffy coat layers' have been removed or by 'washing' of donor cells. Aspirin, antihistamines or steroids may also be given to the recipient if necessary.
• **Immunological sensitisation**. Only the ABO, Kell and Rh(D) groups are considered for blood transfusion. Immune antibodies may be stimulated by transfusion, and may give rise to difficulties with compatibility tests or to haemolytic transfusion reactions.

Infections

There are four main reasons for blood transfusion causing infection in the recipient.
• **Serum hepatitis virus** may be transmitted from the donor and is usually a severe hepatitis arising approximately 3 months after the transfusion. It should be avoided by adequate verbal screening of the blood donor and by testing for the presence of the hepatitis associated antigen in the blood prior to transfusion.
• **HIV infection** can be transmitted by blood and blood products. All donors must be screened (see AIDS in Chapter 7). Haemophiliacs are at special risk because of their more frequent requirements for blood products.
• **Bacterial infection** may result faulty storage. This arises most commonly from the donor blood being left in a warm room for some hours before the transfusion is commenced. This allows proliferation of any bacteria, and transfusion of such infected blood may result in severe septicaemia in the recipient and rapid death.
• **Malaria** can be transmitted by blood transfusion in areas where the disease is endemic. Whenever possible, donors should be screened and the disease eradicated (by treatment of the donors who are positive) before blood is obtained or given. If the need for transfused blood is so urgent that precautions are impossible before transfusion, then the patient should be given prophylactic antimalarial drugs.

Thrombo phlebitis

Air embolism

Coagulation failure

Coagulation failure is due to:
• **dilution of clotting factors/platelets** due to large volumes of stored blood being used to replace losses as stored blood is low in platelets, Factor VIII and Factor V;
• **disseminated intravascular coagulation (DIC)** following an incompatible blood transfusion, particularly ABO incompatibility. The further haemorrhage may be treated by replacement of the deficient factors (usually fibrinogen, Factors VIII, V and II, and platelets), with fresh frozen plasma, cryoprecipitate and platelet concentrates. Paradoxically, heparin may be used sometimes for the treatment of DIC.