Transfusion of blood and blood products

The indications for transfusion in surgical practice are as follows.

1) Following traumatic incidents where there has been severe blood loss, or haemorrhage from pathological lesions, for example from the gastrointestinal tract.
2) During major operative procedures for example abdominoperineal or cardiovascular surgery.
3) Following severe burns where, there may be associated haemolysis.
4) Postoperatively in a patient who has become severely anaemic.
5) Preoperatively, usually in the form of packed cells given slowly 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.
6) 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

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 or 80 mmHg. 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.

Blood storage

All blood for transfusion must be stored in special blood bank refrigerators controlled at 4C ±2C. 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. 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 4C the survival of platelets is considerably reduced, and few are functionally useful after 24 hours. Platelets which are separated) 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. 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. Good packing can be obtained by letting the blood sediment and removing the plasma, or by centrifugation.

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.

Platelet concentrate

Platelet concentrate for transfusion to patients with thrombocytopenia is prepared by centrifugation of platelet rich.

Plasma

This is removed after centrifugation of whole blood 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 4C and is suitable for replacement of protein, for example following severe burns.

Fresh frozen plasma.

Plasma removed from fresh blood stored at _4C 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 4C 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 _4C 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 intravascular coagulation or congenital afibrinogenaemia). It does, however, carry a high risk of hepatitis.

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. 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.

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.

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*
•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 with an absolute filtration rating of 40 micron will filter off platelet aggregates and leucocytes membranes in stored blood.

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 to plasma products in the donor blood. The reaction is treated by stopping the transfusion and giving an antihista-mine 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. Aspirin, antihistamines or steroids may be given to the recipient if necessary.

- ***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 .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. 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.

Haemophilia and the congenital haemorrhagic diseases

Haemophilia

Haemophilia (haemophilia A) is a haemorrhagic diathesis caused by the congenital deficiency in the blood of Factor .It is a sex-linked characteristic, transmitted by the asymptomatic female carriers, and manifest only in males.

The levels of Factor VIII in the blood of severe haemophiliacs may be less than 1 percent of the average normal level. In the case of spontaneous haemorrhage (e.g. into joints) treatment should aim at raising the level to at least 20 per cent. Should surgery be anticipated in the haemophiliac, the level should be raised to 50—100 per cent.

Factor VIII concentrates are superseding cryoprecipitates. The amount of either preparation depends on the problem and the level required for haemostasis, i.e. more for surgery than for a haemarthrosis. Additional forms of therapy may include fresh blood, if necessary for blood loss or fresh frozen plasma.

Christmas disease

Christmas disease (haemophilia B) is a congenital disease resulting from the deficiency of Factor IX (Christmas factor). Clinically, the manifestations of the disease are similar to haemophilia. Factor IX is replaced by the transfusion of fresh frozen plasma, or by reconstituted dried concentrates of human Factor IX.

Von Willebrand's disease

Von Willebrand's disease, with episodic bleeding manifesta-tions, is a type of haemorrhagic disease, with low plasma levels of both Factor VIII complement and Factor VIII related antigen, and platelet abnormalities.

Sickle-cell disorders

Sickle-cell disorders can be a serious problem in surgery, especially with children. All patients of the negroid ethnic type should be screened for the presence of sickle haemoglobin.

Blood substitutes — albumin, dextran, gelatin

One of the most urgent requirements in a patient suffering from acute blood loss is the re-establishment of a normal blood volume. This may be achieved satisfactorily with a number of plasma substitutes.

Human albumin 4.5 per cent has superseded the use of dried plasma and can be used whilst cross-matching is being performed. Two to three units (1.2 litres) are given intravenously over 30 minutes. It is valuable in patients with burns where there has been severe loss of protein. There is no risk of transmitting hepatitis.

Dextrans are polysaccharide polymers of varying molecular weight producing an osmotic pressure similar to that of plasma. They have the disadvantage of inducing rouleaux of the red cells and this interferes with blood-grouping and cross-matching procedures, hence the need for a blood sample beforehand. Dextrans interfere with platelet function and may be associated with abnormal bleeding, and for this reason it is recommended that the total volume of dextran should not exceed 1000 ml.

Gelatin in a degraded form (molecular weight around30 000) is used increasingly as a plasma expander. Up to1000 ml of a 3.4—4 per cent solution (containing anions andcations) is given intravenously (e.g. Haemaccel, Gelafusine).

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