TRANSFUSION

Objectives:

To understand:

1. **The use of blood and blood product.**
2. **The benefits and risks of blood transfusion**

The transfusion of blood and blood products has become commonplace since the first successful transfusion in 1829.

Indications for blood transfusion

Blood transfusions should be avoided if possible and many previous uses of blood and blood products are now no longer considered appropriate. The indications for blood transfusion are as follows:

1. Acute blood loss, to replace circulating volume and maintain oxygen delivery;
2. Perioperative anaemia, to ensure adequate oxygen delivery during the perioperative phase;
3. Symptomatic chronic anaemia without haemorrhage or impending surgery.
4. In a patient with haemorrhagic state (such as thrombocytopenia, haemophilia or liver disease) to arrest haemorrhage or as prophylactic measure prior to surgery.

Blood storage

- All blood for transfusion must be stored in special blood bank refrigerators controlled at 4° C± 2.
- Blood allowed to stand at higher temperatures for more than 2 hours is in danger of transmitting infection.
- The most commonly used anticoagulants for blood storage are:
  - citrate-phosphate-dextrose (CPD): blood storage is limited to 21 days
  - citrate-phosphate-dextrose-adenine (CPDA1) blood storage is limited to 35 days (**5 weeks for WBC, 6 weeks for RBC**).

Blood and blood products

- Blood is collected from donors who have been previously screened to exclude any donor whose blood may have the potential to harm the patient or to prevent possible harm that donating a unit of blood may have on the donor.
- Up to 450 ml of blood is drawn, a maximum of three times a year.
- Each unit is tested for evidence of hepatitis B, hepatitis C, human immunodeficiency virus (HIV)-1, HIV-2 and syphilis.
- Donations are leucodepleted as a precaution against variant Creutzfeldt– Jakob disease (this may also reduce the immunogenicity of the transfusion).

- The ABO and Rhesus D blood group is determined, as well as the presence of irregular red cell antibodies. The blood is then processed into sub-components.

Whole blood

- Whole blood transfusion has significant advantages over packed cells as it is coagulation factor rich and, if fresh, more metabolically active than stored blood.
- The WBC are rapidly destroyed by in stored blood.
- The platelet survival at 4°C is considerably reduced and few are functionally useful after 24 hr.
- Clotting factors V and VIII are labile and their level falls quickly.

Packed red cells

- Packed red blood cells are cells that are spun down and concentrated.
- Each unit is approximately 330 ml and has a haematocrit of 50–70%.
- Packed cells are stored in a SAG-M solution\ (saline–adenine–glucose–mannitol) to increase their shelf-life to 5 weeks at 2–6C. (Older storage regimens included storage in CPD – citrate phosphate–dextrose solutions – giving cells a shelf-life of 2–3 weeks).

Fresh-frozen plasma

- Fresh-frozen plasma (FFP) is rich in coagulation factors;
- it is removed from fresh blood and stored at –40 to –50ºC with a 2- year shelf-life.
- It is the first-line therapy in the treatment of coagulopathic haemorrhage. Rhesus D-positive FFP may be given to a Rhesus D-negative woman.

Cryoprcipitate

- When fresh frozen plasma is allowed to thaw at 4ºC, a white glutinous precipitate remains and if the supernatant plasma is removed, this cryoprecipitate is a very rich sourse of factor VIII and fibrinogen.
- It is stored at - 40 ºC.

Platelets

- Platelets are supplied as a pooled platelet concentrate containing about 250×10^{9} cells per litre.
- Platelets are stored on a special agitator at 20–24ºC and have a shelf-life of only 5 days.
- Platelet transfusions are given to patients with thrombocytopenia or with platelet dysfunction who are bleeding or undergoing surgery.

Prothrombin complex concentrates

- Prothrombin complex concentrates (PCCs) are highly purified concentrates prepared from pooled plasma.

- They contain factors II, IX and X; factor VII may be included or produced separately.
- PCCs are indicated for the emergency reversal of anti-coagulant (warfarin) therapy in uncontrolled haemorrhage.

Autologous blood

- It is possible for patients undergoing elective surgery to predonate their own blood up to 3 weeks before surgery for retransfusion during the operation.
- Similarly, during surgery blood can be collected in a cell saver; this washes and collects red blood cells, which can then be returned to the patient.

Transfusion trigger

- Historically, patients were transfused to achieve a haemoglobin level of > 10 g dl–1. This has now been shown to be not only unnecessary but also associated with increased morbidity and

mortality compared with lower target values.

Haemoglobin level (g/dl)	*Indication*
< 6	Probably will benefit from transfusion
6–8	Transfusion unlikely to be of benefit in the absence of bleeding or impending surgery
> 8	No indication for transfusion

Blood groups and cross-matching

- Human red blood cells have many different antigens on their cell surface.
- Two groups of antigens are of major importance in surgical practice – the ABO and Rhesus systems:

ABO system

- These are strongly antigenic and are associated with naturally occurring antibodies in the serum.
- The system consists of three allelic genes – A, B and O – which control the synthesis of enzymes that add carbohydrate residues to cell surface glycoproteins.
- Expression of the A and B genes results in specific residues being added whereas the O gene is an amorph and does not transform the glycoprotein. The system allows for six possible genotypes although there are only four phenotypes (Table).
- Naturally occurring antibodies are found in the serum of those lacking the corresponding antigen. Blood group O is the universal donor type as it contains no antigens to provoke a reaction. Conversely, group AB individuals are

'universal recipients' and can receive any ABO blood type as they have no circulating antibodies.

Rhesus system

- The Rhesus D [Rh(D)] antigen is strongly antigenic and is present in approximately 85% of the population in the UK.
- Antibodies to the D antigen are not naturally present in the serum of the remaining 15% of individuals but their formation may be stimulated by the transfusion of Rh-positive red cells or they may be acquired during delivery of a Rh(D)-positive baby.

Phenotype	**Genotype**	**Antigens**	**Antibodies**	**Frequency (%**
O	OO	O	Anti-A, Anti-B	46
A	AA or AO	A	Anti-B	42
B	BB or BO	B	Anti-A	9
AB	AB	AB	None	3

Cross-matching

- To prevent transfusion reactions, all transfusions are preceded by ABO and Rhesus typing of both donor and recipient blood to ensure compatibility.
- The recipient's serum is then mixed with the donor's cells to confirm ABO compatibility and to test for Rhesus and any other blood group antigen–antibody reactions.
- Full cross-matching of blood takes 45 min in most laboratories.
- In more urgent situations, 'type-specific' blood is provided, which is only ABO/Rhesus matched and can be issued within 10–15 min.
- When blood must be given in an emergency, group O (universal donor) blood is given (O– to female patients, O+ to male patients).
- When prescribing and administering blood it is essential that the correct patient receives the correct transfusion. Two individuals should check the patient details against the prescription and the label of the donor blood.

Complications of blood transfusion

Complications from blood transfusion can be categorised as those arising from a single transfusion and those related to massive transfusion.

Complications from a single transfusion: include:

1. **Incompatibility haemolytic transfusion reaction;** occurs If antibodies present in the recipient's serum which are incompatible with the donor's cells. Severe immunerelated transfusion reactions caused by ABO

incompatibility result in severe and potentially fatal complement-mediated intravascular haemolysis and multiple organ failure. The patient develops rigor, fever and pain in the in the loins, pink or red urine (hemoglobinuria). and may become extremely alarmed.

Treatment: Stop transfusion immediately, fresh specimen of the venous blood and urine from the patient sent together with all remained donor blood to the labrorotory for checking. Close follow up of the patient pulse, blood pressure and urine output.intravenous fluids and diuretics may be indicated.Frusemide 80-120 mg i.v. is given to provoke diuresis and repeated if urine output falls below 30 ml/hour. Dialysis may be necessary. Transfusion reactions from other antigen systems are usually milder and self-limiting.

2. **Febrile transfusion reaction;** the patient develops fever, rigor and some increase in the pulse. It is the result of pyrogen in the donor apparatus and largely avoided by the use of disposable plastic giving sets.
3. **Allergic reaction**; in which mild tachycardia and an urticarial rash and rarely an acute anaphylactic reaction occur. It is due to allergic reaction to plasma products in the donor blood. Treated by stopping transfusion and giving antihistamine drug.
4. **Infection:**
   - -bacterial infection (usually as a result of faulty storage);
   - -hepatitis;
   - -HIV;
   - -malaria;
5. **Air embolism**;
6. **Thrombophlebitis;**
7. **Transfusion-related acute lung injury (usually from FFP).**

Complications from massive transfusion

Complications from massive transfusion include:

1. **coagulopathy;** occur due to dilution of clotting factors and platetes,or due to disseminated intravascular coagulation(DIC) following incompatible blood transfusion.
2. **hypocalcaemia;**
3. **hyperkalaemia;**
4. **hypokalaemia;**
5. **hypothermia.**

Additionally, patients who receive repeated transfusions over long periods of time (e.g. patients with thalassaemia) may develop iron overload. (Each transfused unit of red blood cells contains approximately 250 mg of elemental iron.)

Massive Blood Transfusion is loosely defined as the transfusion of more than 10 units of blood in a 24-hour period Or the replacement of more than 50 % of a patient blood volume in 12 to 24 hours.

Management of coagulopathy

Correction of coagulopathy is not necessary if there is no active bleeding or haemorrhage is not anticipated (no impending surgery); however, coagulopathy following or during massive transfusion should be anticipated and managed aggressively. Standard guidelines are as follows:

- FFP if prothrombin time (PT) or partial thromboplastin time (PTT) > 1.5 ×normal;
- cryoprecipitate if fibrinogen < 0.8 g /1;
- platelets if platelet count < 50 $\times 10^9$ /ml.

However, in the presence of non-surgical haemorrhage these tests take time to arrange and they may underestimate the degree of coagulopathy. Treatment should then be instituted on the basis of clinical evidence of non-surgical bleeding.