BLOOD GROUPS AND BLOOD TRANSFUSION

BLOOD GROUP ANTIGENS AND ANTIBODIES

- Over 20 blood group systems having approximately 400 blood group antigens are currently recognised.
- The ABO and Rhesus (Rh) blood group systems are of major clinical significance.
- less important blood group systems are: Lewis system, P system, I system, MNS system, Kell and Duffy system, and Luthern system.

ABO SYSTEM

- consists of 3 major allelic genes: A, B and O, located on the long arm of chromosome 9.
- There are four main typrs of blood group- A, B, AB, and O.
- Antigens of ABO system are: A (A1, A2), B and H.
- In addition to RBC, they are also expressed on WBC, platelets and various body secretions.
- Acc to Landsteiner's law, anti-A or anti B antibodies are always present in plasma of individual who lack corresponding antigen on their red cells.
- These antibodies are usually of IgM class.

- An O group individual who inherits A or B genes but fails to inherit H gene from either parent is called Oh phenotype or Bombay blood group.
- These individuals contain anti-A, anti-B and anti-H. Therefore, Oh blood group persons should be transfused only with Oh blood.

RHESUS SYSTEM

- The Rh allelic genes are C or c, D or d and E or e, located on chromosome 1.
- The importance of this system lies in high immunogenecity of Rh D antigen, which can cause severe hemolytic reaction.
- The presence of D in either homozygous or heterozygous state make the individual Rh positive, while Rh neg individuals are homozygous for d (d/d).
- Rh antigens are expressed on RBCs only and not on any other tissue.
- There are no naturally-occurring Rh antibodies

BLOOD TRANSFUSION

Pre-transfusion compatibility testing

- ABO and Rh(D) grouping of the patient (recipient).
- Antibody screening of the patient's serum to detect the presence of clinically significant antibodies.
- Selecting the donor blood of the same ABO and Rh group.
- Cross-matching the patient's serum against donor red cells to confirm donor-recipient compatibility.

Complications of Blood Transfusion

- Immunologic transfusion reactions- against red blood cells (haemolytic reactions), leucocytes, platelets or immunoglobulins.
- Non-immune transfusion reactions
- Circulatory overload in massive transfusion
- transmission of an infectious agent.

IMMUNOLOGIC TRANSFUSION REACTIONS

Haemolytic transfusion reactions

- may be immediate or delayed,
- intravascular or extravascular

ABO incompatibility:

- Very rapid cell destruction
- Intravascular haemolysis
- naturally-occurring antibodies, anti-A and anti-B, fix complement.
- symptoms include restlessness, anxiety, flushing, chest or lumbar pain, tachypnoea, tachycardia and nausea, followed by shock and renal failure.

Rh incompatibility:

- Extravascular haemolysis
- anaemia due to destruction of red cells in the RE system
- The clinical manifestations are relatively less severe and usually consist of malaise and fever but shock and renal failure may rarely occur

Transfusion-related acute lung injury (TRALI)

- Transfusion of donor plasma containing high levels of anti-HLA antibodies which bind to leucocytes of recipient.
- leucocytes then aggregate in pulmonary microcirculation.
- increased vascular permeability resulting in acute pulmonary oedema

- **Febrile reaction**: attributed to immunologic reaction against white blood cells, platelets, or IgA class immunoglobulins.
- **Graft-versus-host disease:** mediated by donor T lymphocytes

NONIMMUNE TRANSFUSION REACTIONS

Circulatory overload:

- result in pulmonary congestion and acute heart failure
- Risk factors: chronic anaemia, in infants and elderly.
- onset may be immediate, or may be delayed up to 24 hours.

Massive transfusion:

- dilutional thrombocytopenia and
- dilution of coagulation factors.

Transmission of infection:

- hepatitis (HBV, HCV),
- CMV infection,
- syphilis,
- malaria,
- toxoplasmosis,
- infectious mononucleosis,
- Brucellosis and
- AIDS (HIV infection)

Thrombophlebitis:

- associated with venesection
- if it is done in the saphenous vein of the ankle rather than the veins of the arm
- if the transfusion is continued longer than 12 hours at a single site

Transfusion haemosiderosis:

- in thalassaemia major
- liver, myocardium and endocrine glands are all damaged.

BLOOD COMPONENTS

Blood components

- packed RBCs,
- platelets,
- fresh-frozen plasma (FFP) and
- cryoprecipitate.

Collection

- procedure consists of initial centrifugation at low speed to separate whole blood into two parts: packed RBCs and platelet-rich plasma (PRP).
- Subsequently, PRP is centrifuged at high speed to yield two parts: random donor platelets and FFP.
- Cryoprecipitates are obtained by thawing of FFP followed by centrifugation.
- Apheresis is direct collection of large excess of platelets from a single donor.

Applications

1. Packed RBCs:

- normovolaemic patients of anaemia
- without cardiac disease.
- One unit of packed RBCs- raise haemoglobin by 1 g/dl

2. Platelets:

- Patient with platelet count below 10,000/µl.
- raise platelet count by 5,000 to 10,000/µl

3. Fresh frozen plasma:

- FFP contains plasma proteins and coagulation factors that include albumin, protein C and S and antithrombin.
- indicated in patients of coagulation failure and TTP
- Each unit of FFP raises coagulation factors by about 2%

4. Cryoprecipitate:

- plasma proteins, fibrinogen, factor VIII and vWF
- patients requiring fibrinogen, factor VIII and vWF
- Transfusion of single unit of cryoprecipitate yields about 80 IU of factor VIII

HAEMOLYTIC DISEASE OF NEWBORN

- passage of IgG antibodies from the maternal circulation across the placenta into the fetal circulation.
- HDN can occur from incompatibility of ABO or Rh blood group system.
- ABO incompatibility is much more common but the HDN in such cases is usually mild,
- Rh-D incompatibility results in more severe form of the HDN

HDN due to Rh-D incompatibility

- Rh incompatibility occurs when a Rh-negative mother is sensitised to Rh-positive blood
- Sensitisation occurs -passage of Rh-positive featlred cells across the placenta into the circulation of Rh-negative mother
- Normally, during pregnancy very few foetal red cells cross the placenta but haemorrhage during parturition causes significant sensitisation of the mother.
- 95% cases of Rh-HDN are due to anti-D,
- some cases are due to combination of anti-D with other immune antibodies of the Rh system such as anti-C and anti-E, and rarely anti-c alone

HDN due to ABO incompatibility

- Naturally-occurring anti-A and anti-B antibodies which are usually of IgM class do not cross the placenta.
- while immune anti-A and anti-B antibodies which are usually of IgG class may cross the placenta into foetal circulation and damage the foetal red cells

CLINICAL FEATURES

- severe form may result in intrauterine death from hydrops foetalis
- Moderate disease- severe anaemia and jaundice due to unconjugated hyperbilirubinaemia.
- When the level of unconjugated bilirubin exceeds 20 mg/dl, it may result in deposition of bile pigment in the basal ganglia of the CNS called kernicterus.
- Mild disease- severe anaemia with or without jaundice.

LABORATORY FINDINGS

- Anaemia with reticulocytosis,
- Increased nucleated RBC and polychromasia
- elevated serum bilirubin
- positive direct Coombs' test
- Mother's blood- Indirect Coomb's test- anti-D antibodies.

Treatment

- Exchange transfusion
- Phototherapy- converts unconjucated bilirubin into soluble form, that is excreted in urine.
- Infusion of bile- binds free bilirubin in plasma and thus decreases the risk of kernicterus.

Prevention

- All Rh D –ve women are given RhIg within 72 hrs of delivery of Rh +ve infant.

	Rh HDN	ABO HDN
Frequency	Less common	More common
Blood group Mother Fetus	 Rh neg Rh positive	 O A or B
Pregnancy affected	Usually second	Usually first
Severity	Severe	Mild
Blood smear	Erythroblastosis	Spherocytosis
DCT	Strongly Positive	Weakly positive or Negative
Prevention	Rh immune globulin	Not available